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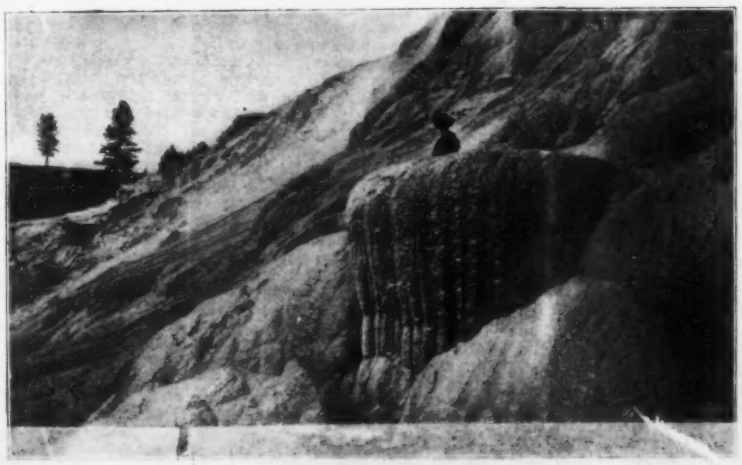
THE GREAT GEYSER BASIN OF YELLOWSTONE PARK.

"OLD FAITHFUL."

EXCELSIOR GEYSER BASIN. PRISMATIC TERRACE.

THE GIANT.

CRATER OF THE GREAT FOUNTAIN.



THE PULPIT. MAMMOTH HOT SPRINGS.

CRATERS OF THE GRAND AND TURBAN GEYSERS.

YELLOWSTONE GEYSERS.

THE GEYSERS OF YELLOWSTONE PARK.

By DAY ALLEN WILLEY.

THE plateau on which the Yellowstone Park is situated is a vast amphitheater where for ages a wonderful spectacular performance has been in progress, caused by chemical action beneath the surface. Nowhere else in the world can be seen such a variety of hot springs, geysers, terraces, and other forms of activity, for the Iceland and New Zealand localities are limited, and the eruptions are small when compared with this great natural park of America. It is unnecessary to refer to the opportunities which it has afforded the scientist to study geological formation, for the Yellowstone canon, as well as the hill and the mountainside, have formed a book of Nature, to quote an eminent geologist, which has revealed remarkable secrets. The petrified forests, the marvelous hills composed of glass, sulphur, and cinders, as well as the mountain ranges which bound the park, some of them still containing glaciers, form an appropriate setting to the performance of Nature which is continually in progress. The most eminent geologists agree that the volcanic eruptions of the past, the results of which are everywhere visible, covered this portion of the country in places to a depth of 5,000 feet, and many of the openings from which steam, water, and mud are being thrown were probably made through such a depth of solid material. Mountain, plateau, and valley alike give evidence of the tremendous eruptions which have occurred in past ages—not one, but a series of convulsions, between which have probably elapsed centuries, when the masses of earth and rock were again covered with vegetation in various forms, all to be changed later by the fire, steam, lava, and other deposits from the bowels of the earth. The peaks around the plateau include a number of so-called extinct volcanoes, among them the three Tetons, perhaps the most interesting summits in this region of volcanic action, unless Electric Peak be included. It is on its summit that the visitor experiences the effect of a violent electric shock should he chance to make the ascent during a thunderstorm. It seems to be charged with electricity under certain conditions, and frequent lightning flashes are to be noted about it during a storm.

While the geysers of Iceland and New Zealand are noted for their size and height, they are insignificant contrasted with the "Excelsior," "Castle," and "Giant"; the "Excelsior" at times throws into the air a volume of water which is estimated to be from 50 to 60 feet in circumference and to often attain a height of 250 feet. Many of these great fountains reach a height of from 150 to 200 feet, while some issue from the earth as regularly as the beats of a clock pendulum. It is hardly necessary to refer to what is known as "Old Faithful," which throws its volume of water into the air every 65 minutes, not varying five minutes between its periods of activity. When it is considered that over one hundred of the geysers are in operation, while over four thousand springs of various kinds have been counted in the park, varying in size from the "Prismatic," whose rim is 200 feet in circumference, to mere spurts of hot water sometimes issuing beneath the roots of a tree, a faint estimate can be obtained of the widely distributed activity; but the springs and geysers represent only a part of the activity. The terraces, which have been the study of scientists since the days they first became known to the white men, are caused by water forcing its way through the sides of cliffs, carrying with it the material from which their glittering and various-colored formation is largely composed. While some of these cataracts have ceased to flow, others have undoubtedly been active for hundreds of years, according to the investigations of experts, who say it is marvelous that the deposits thrown out with the water have not choked the openings. This fact also indicates the extent of the power, perhaps as strikingly as the play of the great geysers.

A study of the basins or craters—the openings from which the columns of water issue—and the other shapes of the earth's crust, is extremely interesting from a scientific standpoint. "Liberty Cap," in the vicinity of the Mammoth Hot Springs, is merely an upheaval of the earth caused by a former geyser or fountain, which has since found an opening elsewhere or whose force has been exhausted from some cause. The "paint pots," as basins of the mud springs are called, are craters in shape and appearance, only on a miniature scale. The "mud volcanoes" throw out a stream of thick, black liquid 60 and 100 feet in the air, sometimes with such power as to cover branches and trunks of the trees in the vicinity. Here and there can be found perfectly formed craters on the tops of peaks composed of earth, which has been forced upward 20 or 30 feet above the surrounding level. Every tourist in the park is familiar with the clouds of steam which are continually ascending from the groups of springs, and more than one has nearly lost his life by venturing too near one of these openings and becoming nearly suffocated. Almost constantly one hears the rumblings of the earth, sometimes so loud as to be almost deafening if he chances to be in the vicinity of some of the larger openings. The guides appropriately call this the "earth's thunder."

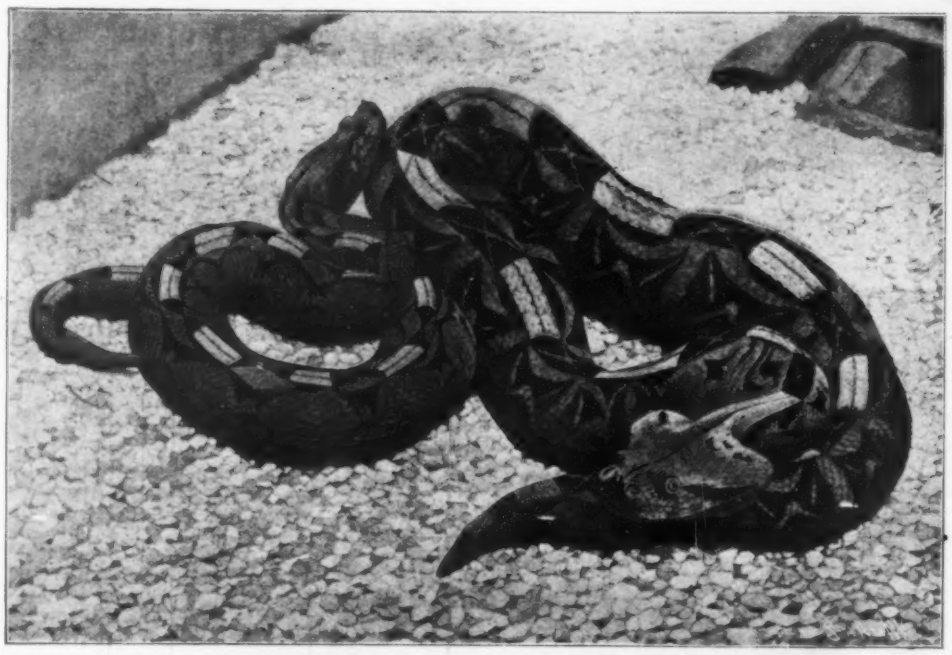
The name given to the region by the pioneer white men who visited it, "Coulter's Hell" (Coulter being one of the first, if not the first, to visit the springs), was well applied to features of it, and such titles as the "Devil's Caldron" were given to some of the basins, but in other portions, as is well known, the natural beauty presents the strongest contrast. The terraces in themselves are wonderfully picturesque, yet the solid material of which they are composed is principally lime and silex carried from the interior by the force of water. The geysers rising in the air frequently take the form of trees and bushes, while several are noted for their resemblance to other familiar objects. The action of the hot water, forced through the various strata on its way to the surface, has literally boiled the formation into a paste or mud; but only a portion of this is of the repulsive black color, as the surroundings of some of the springs contain yellow, brown, pink, gray, lavender, and white tints very clearly defined. The blending of these hues has produced the exquisite effects which have attracted so much admiration from visitors, while particles of crystal and other substances, forced up with the water, have been deposited upon the sides of the basins, giving many of them their sparkling appearance. As is well known, some of the springs themselves are of a varied hue, probably the most celebrated being the great "Prismatic" spring, where the water in the center appears a deep blue, gradually fading to green on the edges, caused of course by chemical action.

In a tour of the park such a variety of effects produced by subterranean action can be seen, that to attempt to mention them all would be a hopeless task; but not only can the visitor get an idea of the desolation and ruin caused by this activity, but the beautiful creations which can also be wrought by it, while every opening in the earth, whether the basin of a spring, the origin of a terrace, or the crater of a geyser, represents a vent for the underground gases, which, if closed, might result in dangerous upheaval. All of these fissures in the earth, which give the Yellowstone Park such a fascination, combined form a mammoth safety valve, that has no parallel in the world. Were it not for them, geologists admit that possibly the violence of past ages might be repeated to a certain extent.

RHINOCEROS ADDERS IN THE BERLIN AQUARIUM

THE rhinoceros adder, represented in a very lifelike manner in the picture drawn by Siemenroth, is an inhabitant of the German protectorates in Africa, but, being a poisonous snake, it does not in any way contribute to the comforts of those parts.

Outside of the asp (African Cobra or *Naja haje*), known from olden times, and the widely distributed puff-adder (*Bitis* or *Vipera orientans*), other and rarer varieties of African poisonous serpents have latterly reached the Berlin Aquarium through the kindness of German explorers and collectors. Among others were received for the first time two specimens of the rhinoceros adder, the smaller and weaker one of which has since died.



RHINOCEROS ADDERS IN THE BERLIN AQUARIUM.

This viper is exceedingly corpulent considering its length, has a short, blunt tail and a flat, broad head, and if we note merely the structure of the body, we might imagine we have a puff-adder before us. But a glance at the fore-part of the head teaches us otherwise, since the rhinoceros adder has no singly carinated upper-nose shields, but a little horn at the inside edge of each nostril, which has originated by the transformation of the said upper-nose shield. To these cutaneous little horns is due the name rhinoceros adder (*Bitis* or *Vipera rhinoceros*), derived from the well-known uncouth mammal, only that in the case of our serpent the horns are not in a line running from the front to the back, but crosswise, if viewed from the front. According to the right of priority, the species name, rhinoceros, given by Schlegel and used for decades, has of late had to give way to Dumeril's appellation *gabonica*, so that the snake is now kept in the museums under the name of *Bitis gabonica* (Gabun or Gaboon adder).

Of unique beauty is the coloring of the scaly dress of this reptile, which is not perceptible in the alcohol specimens in the museums at all, and which appears in its full perfection and freshness only after the snake has cast its skin, which it does several times a year, when the old one has become worn and unsightly.

The fundamental color of the upper side is generally a deep brown, with a cast of black or dark green; that of the under side a whitish or yellowish gray. On the back, from the nape to the point of the tail, runs a row of dark yellow rhombic spots circumscribed by dark yellow lines, which generally touch with their points in the spinal line, and inclose each a sand-colored, or reddish yellow, rectangle of a delicate, pearl-gray shade, at the back and front, while in the deep-brown field between every two of these rectangles an hourglass-like figure is formed by the points of the triangles of the rhombs touching each other. The above-mentioned dark-yellow border lines are accompanied on the under side by festoon-like, pale bluish-gray stripes. Below the hourglass figure is a triangular yellowish brown field widening toward the edge of the trunk and outlined in dull yellow, with a vertical, broad, pale-blue stripe of a golden yellow tinge running through the middle. Between every two of these fields there appears on the body's edge a low, truncated triangle, and the flank portions along the edge of the trunk show mixed colors of reddish, yellowish, and dull gray hues. The foremost of the said rectangles broadens out from the front of the neck to the width of the top of the head, which is generally of a darker, grayish-red color, and traversed lengthwise by a blackish line, while the temples and some spots at the back of the head have a brownish-black coloring. The point of the tail is a sandy yellow, while the iris is yellow to yellowish red.

According to proofs received, the home of this venomous snake appears to be the West African coast districts from Liberia (Cape Palmas) in the north to Damaraland in the south, hence including the German possessions, in West Africa, especially the Cameroons, where it seems to be very numerous. Latterly, however, according to the verbal statement of Dr. G. Tornier, custodian of the reptile collection at the Royal Museum of Natural History, who received a specimen from Tanga in Usambara, it has also been found in German East Africa. And since it has also been met with in Zanzibar and Mozambique, we may safely say that the zone of existence of the rhinoceros adder embraces the parts of Africa between the eighth and tenth degrees of north latitude and the southern tropic, so that it extends over thirty odd degrees of latitude and fifteen degrees of longitude.

The most pronounced characteristic of this serpent is its indolence. Nocturnal in every sense of the term, it moves during the light hours only if forced from a position once occupied, while at dusk and in the dark it crawls around slowly, and if hungry partakes of food. More than one large white or whitish variegated rat per week, it does not require at the Berlin Aquarium. In this connection it has been observed that this snake does not, like other poisonous snakes, first bite the rodent and then release it again, only to seize and swallow it after the poison has caused the victim's death, but that it holds the bitten quadruped at once in its opened jaws, and promptly forces it down.

Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Illustrirte Zeitung.

TURTLE FISHING IN MADAGASCAR.

THE Bulletin Economique de Madagascar describes the method which is employed by the natives for capturing the turtles and obtaining the tortoise-shell. The fisher is well acquainted with the habits of the turtle. It is remarked that it prefers the irreguiar parts of the shore, rocky beaches, bays, and creeks, and shuns the flat and sandy beaches; it generally comes to shore the first time to explore the ground, and is then somewhat difficult to catch, at least if it is not very far inland, and its retreat cannot be cut off. Generally it succeeds in reaching the water. But the fisher does not try to capture it on the first visit; he knows that 12 to 15 days after, it will come back to the place which has been explored in order to lay its eggs, and at that time it is easy to catch. It then comes to shore, even in the presence of persons, and goes to the point it has chosen for laying. The native does not usually wait until it has finished laying, or even commenced. He captures it and turns it over on its back, then proceeds to prepare it. It often happens that the fisher has not been present at the exploring trip, and may not be prepared to catch it. If he comes too late, nothing is lost as he observes the trace of the turtle upon the sand and knows that 17 days after the first lay it will come back to the same place for the second. He thereupon lies in wait for it at the time fixed. The turtle comes to shore at high tide, during the night or day, but in December, when the heat is greatest, it comes at night. The eggs are laid in the sand, usually 120 to 150 feet from the water. It can lay from 150 to 200 eggs in two sittings. The hatching lasts about 20 days, and the small turtles, as soon as they come out of the egg, start for the sea.

When the fisher has turned the turtle upon its back, he detaches the flat scale from the breast with a blade; this part has no commercial value. He then takes all the flesh out of the shell with a knife. The flesh may

be eaten, but is unhealthy, as it is apt to contain poisonous elements. The hollow shell is then placed over a slow fire, whose heat raises the scales in plates of about 10 inches long and 6 inches wide. These plates are rubbed with the grease of the turtle, so as not to dry too quickly. Some natives, to prevent the drying, bury them in the ground, while others, to increase the weight, bury the plates in mud.

The latter proceeding, if it increases the weight, also injures the shell, and the native does not profit much by it. The shell-tortoise measures from 12 to 20 inches long, and one turtle can yield from 70 to 90 pounds of shell. The latter is sold at $3 to $4 the pound, and the extra quality may bring as high as $5, while the inferior portions sell for $1 or $2. The fishers usually sell their product to the natives of Vohemar and Antsirane. An expert fisher can usually capture 15 or 20 turtles during a good season.

SELF-REGISTERING ELECTRIC WATTMETERS.

ELECTRIC meters are now giving entire satisfaction in the industries, and it may be asserted that they are very precise and accurate apparatus. In the month of February, 1902, M. Gaston Roux, superintendent of the Bureau of Control of Electric Installations at Paris, gave in his annual report, the results of the tests to which a total of 2,390 meters at Paris and 400 in the country had been submitted. As regards Paris, he found 74 per cent of the meters accurate, 5 per cent fast, and 18 per cent slow. As regards the country, the proportion of the slow meters was 75 per cent. It must be added that the tests were made in a very vigorous and precise manner at various powers. An endeavor was made, likewise, to ascertain the lowest powers at which the meters began to register the consumption; and the only meter that was considered as accurate was the one that satisfied every condition.

We ourselves have had occasion a number of times to make such tests, and have found that the majority of the meters operate with absolute accuracy. If we had an observation to formulate, we should find, on the contrary, that the regulation of meters is too often effected with some little retardation. And all such observations are very just, because the electric meter, unlike water and gas meters, is always examined and verified upon the spot, after it has been installed in the electric circuit of which it is to register the consumption.

Electric meters, the first types of which, at the competition of the city of Paris in 1890, gave entire satisfaction, have been continually improved, and we shall now make known some further improvements that have been introduced into the Thomson and Aron meter, which is in universal use.

Fig. 2 represents a Thomson meter of the new type "A," which the company is constructing. This apparatus, like all meters of the kind, consists of a motor with a brake, but the disk *A* is placed at the upper part. The number of revolutions of the armature is registered by a clockwork movement. The pieces, as a whole, are placed in a box that may be seen represented in the figure. At the bottom of the box, at *B*, there is an aperture, which is traversed by the shaft carrying the commutator, or collector, against which the brushes rub. It is into this essential part of the meter, which is submitted to periodical cleaning, that the manufacturers have introduced several improvements.

The collector is formed of small silver plates mounted spirally in order to render the friction of the brushes regular. The extremities of the plates are cut in such a way as to leave between them intervals wide enough to prevent the formation of short circuits by dust. The brushes are formed of a metal plate that pivots around a shaft. Each brush is arranged in such a way as to prevent starts due to shocks. A flexible spring, fixed to the shaft at its lower end and to the brushes at its upper one, assures the contact of the brushes and collector. A special arrangement has been adopted for securing the armature when the meter has to be carried.

The collector, the brushes, and the lower support of the shaft are placed in a box, *B*, with an independent cover. It is thus possible by removing this box to proceed to the cleaning of the collector and brushes, without opening the indicator and the disk of the meter. This is a happy modification which will prove very useful for the keeping of meters in repair.

The same improvements have been introduced by the company into the O. K. meter, type Z. The collector and brushes which also have been improved, have likewise been placed in a special box *B*, fixed at the bottom of the apparatus to the principal box that covers the various other parts. It can be removed separately with the greatest ease. Finally, the magnet has been elongated at the lower part so that the armature *A* shall be placed entirely in the magnetic field of the magnet.

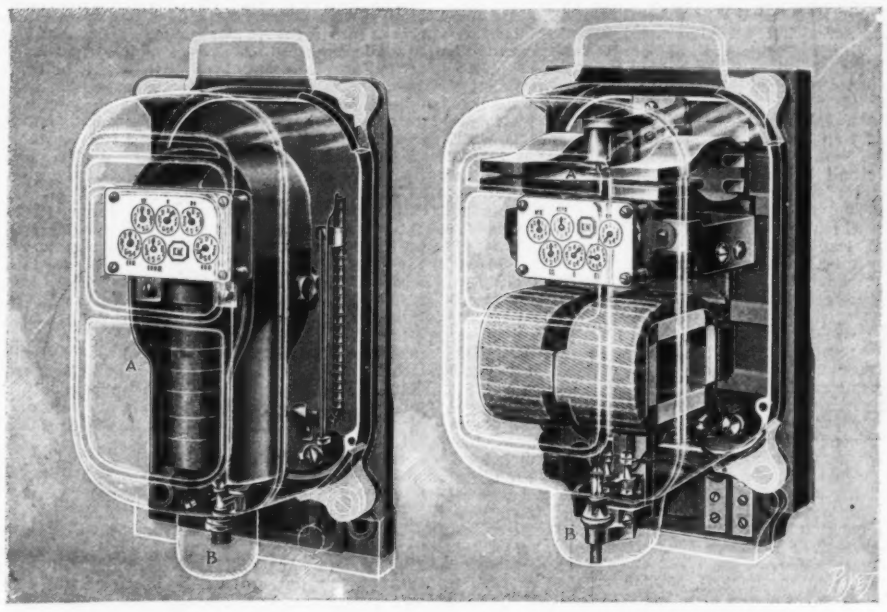


FIG. 1.—THE O. K. WATTMETER, TYPE Z.

FIG. 2.—THE THOMSON WATTMETER, TYPE A.

The electric meter of the Aron type has also undergone a series of improvements that make it at present an almost perfect apparatus. The principle remains the same, the influence of the current being, as before, utilized for measuring the duration of a pendulum's swing. But arrangements have been made for the automatic registering, with very feeble expenditure of electric energy. The pendulums now used are but 4 inches in length and make about 12,000 oscillations an hour. They are two in number, and each is provided with a distinct clockwork movement. The escapement wheels of the two movements are in gear with the toothed wheels of a differential train, of which the planet wheel remains stationary or revolves around an axis, according as the wheelwork of the movements has the same angular velocity or different velocities. The pendulums carry coils of fine wire through which passes a current taken from the terminals, and of the voltage to be measured. These coils displace themselves in front of other coils interposed in the general circuit. The connections of the coils are established in such a way as to increase the number of oscillations of one of the pendulums and diminish those of the other. The influence of the electric current intervenes to cause the advance of one of the pendulums and the retardation of the other. The electric energy to be measured is proportional to the difference of the number of the oscillations effected by the pendulums. The planet wheel, in revolving, then actuates the minute-train of the meter proportionally to such difference, and the electric energy is registered. Fig. 3 gives an internal view of a two-wire meter.

The difference of the numbers of oscillations is proportional to the electric energy to be registered, provided that the synchronism of the pendulums is assured. Such a condition is difficult to fulfill with so short pendulums. To annul the error, it occurred to M. Aron, to cause their rôle to intervene periodically. The result is that the error is null. Moreover, the use of two pendulums, influenced in alternately opposite directions, prevents the bobbins of the meter from being affected by external magnetic influences.

The reversal of the current takes place automatically every ten minutes, with the aid of a small electric commutator controlled by a motive spring, which is set regularly by a wheel that is revolved by the motion of the meter. The automatic winding is effected by an electro magnet, which operates by means of an automatic interrupter. The winding takes place about every forty-five seconds.

The Aron meter is used likewise in 3- and 5-wire distributions. Figs. 4 and 5 show the arrangements adopted in such a case. In all that precedes, we have spoken only of the models of continuous current meters, but there are also meters of the same type for alternating and polyphased currents. There are likewise several other meters approved by the city of Paris and which are in service upon the distributing mains; but we cannot describe them all. We shall be content to mention, for alternating and continuous currents, the Vulcain, Japy, and Le Mars meters.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

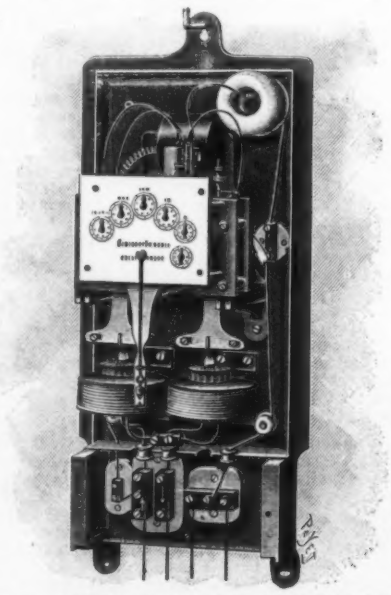


FIG. 3.—ARON AUTOMATIC WATTMETER FOR TWO WIRE CIRCUITS.

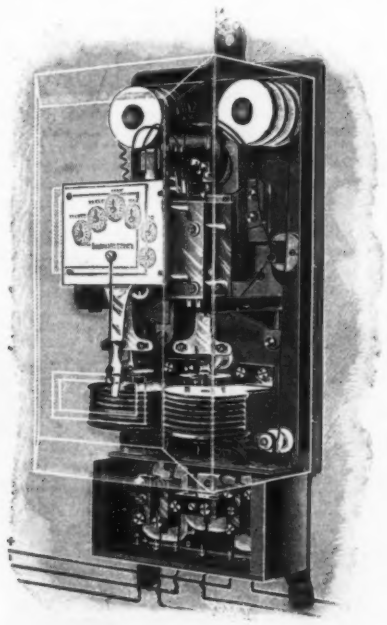


FIG. 4.—ARON METER FOR THREE WIRE CIRCUITS.

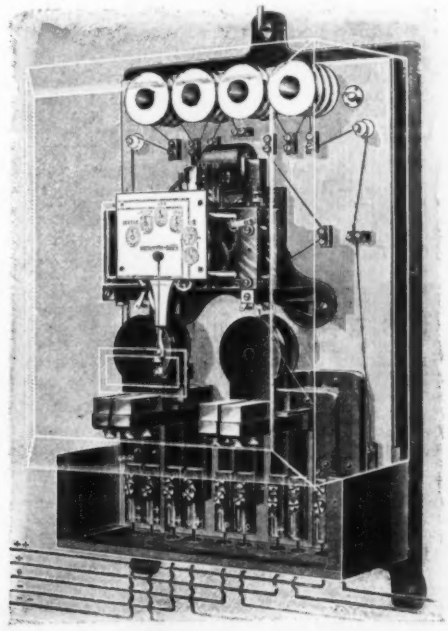


FIG. 5.—ARON METER FOR FIVE WIRE CIRCUITS.

STORAGE BATTERY INVENTION.

THIS question formed the subject-matter of a able paper by Mr. Hugh Rodman, contrasting the merits of lead and nickel batteries. It was po out that besides charge and discharge, storage teries must withstand overcharge, a putting in of ampere hours than can be taken out; and this condition implies unchanging electrodes in an unchanging electrolyte. After discussing numerous possible storage battery combinations and the corresponding reactions, the conclusion is reached that the list of available anodes and electrolytes finally reduces to lead in sulphuric acid and nickel in an alkali hydroxide.

This does not mean the active material must necessarily contain nickel or lead, but simply that the grid, the current carrying part of the oxygen plate upon which the active material rests, must be one or

the other of these metals in its appropriate solution. The active material of the oxygen plate, considering permanency only, may be any insoluble oxide or salt; while the grid and active material of the hydrogen plate, putting aside as impracticable any dissolving material, such as zinc, may be either of the same metal as the oxygen plate, as lead in sulphuric acid, or else of some other metal soluble only at the end of a complete reversal of current, as iron in hydroxides. Practically, this all reduces to two classes: First, lead peroxide and spongy lead upon lead plates in sulphuric acid, the battery in general use; and, second, mercuric or nickel peroxide upon nickel plates, together with cadmium, nickel, or iron sponge upon iron or nickel plates in an alkali hydroxide, the battery proposed by Mr. Edison. As the most promising member of this latter type, we may take an oxygen plate of nickel peroxide upon nickel with a hydrogen plate of iron sponge upon iron and compare it with the usual Planté and Faure types of lead cell.

The alkali battery possesses a great advantage in making its support plates of a stiff, easily-worked metal. The stiffening insures absence of buckling, a trouble which must be considered and compensated for with lead plates, while the stiffness and ease of working together admit of a high mechanical perfection. It should be borne in mind, however, that the ordinary antimonial lead grid used with pasted lead plates is neither prohibitively heavy nor short lived; it will probably last as long as the nickel grid when subjected to electrolytic action only; the inferiority lies in its mechanical weakness and in the difficulty of making fine castings.

Lead peroxide is a conductor. We can use it in comparatively large and porous masses. Nickel peroxide is not a conductor, and so must be held in close contact with some conductor itself inactive, as nickel or carbon. This may be done in two ways: First, by peroxidizing a highly-developed surface of nickel, corresponding with the Planté form of lead plate; second, by packing the active material or material to become active with powdered or flake graphite, held rigid in a perforated box.

An objection to the first method is, that as nickel peroxide does not conduct, only a thin layer of low capacity can be utilized; another objection is that the disintegration by shedding is even more pronounced than with lead, and without the advantage of a continuing and compensating formation of the remaining metal. An objection to the second method is that the dense active mass impedes diffusion. An advantage is that the close-held mass with its stiff, finely-perforated cover is apparently not subject to deterioration. It is well to note that the disintegration of one plate and long life of another is in no way due to the intrinsic qualities of one or the other active material, or to the difference in chemical action taking place; there is no apparent reason why lead peroxide reducing to lead oxide or to lead sulphate should fall to pieces any more quickly than nickel peroxide reducing to nickel oxide—in fact, the reverse is true. The difference lies entirely in the method of holding the active material and in its porosity.

For hydrogen carrying materials, we have spongy porous lead in the acid cell, and in the other spongy iron or a low oxide of iron packed with flake graphite. Here we see no reason why the spongy lead plate should not last indefinitely, and, until recent years, this was supposed to be the case. It loses no material; it does not change chemically; but actually, its capacity lessens with age, and so, while its deterioration is not so rapid as that of the peroxide plate, it must nevertheless be occasionally renewed. The opposite is now hoped for the iron plate; its active material is held rigid by a stiff grid and unchanging graphite packing, and, apparently, should not lose capacity; this, however, for either iron or nickel can be proved only by a much longer life test than the plates have yet had.

One battery uses an acid solution that is absorbed during the discharge by the active material of both plates, and released upon charge. The other uses a solution of potassium hydroxide that is inactive except as an electrolytic conductor, a means of carrying oxygen from one plate to the other. The result of this difference in electrolytes is most important; in the alkali battery we use only enough electrolyte to make a path for the current, while the acid battery must have a mass of electrolyte large enough to hold both the acid needed for the reactions and enough over to insure low electrolytic resistance at the end of discharge. Now while the possibility of using a small amount of electrolyte, which means putting the plates close together, is one of the important factors in making the alkali battery light enough and small enough for commercial practice, this very advantage adds greatly to an already serious trouble—refilling. In overcharging, a portion of the water is uselessly decomposed, passes off as a gas, and must be replaced. The actual amount lost is fixed by the time of overcharge and by the current. The relative amount lost is inversely proportional to the volume of solution in the full cell.

Here the alkali cell is inferior to the lead cell. First, the overcharge is greater. The densely-packed active material allows of only slow diffusion in its mass, with the result that a large proportion of the current breaks up the electrolyte at the surface of the nickel plate, rather than pass through the attenuated alkali solution held in the active material and maintained there by the outward electrolytic movement of the potassium ions. Second, the current is greater. The voltage of the alkali cell is only about one-half that of the lead cell; therefore, for the same energy output, we must double either the current or the number of cells, so multiplying the useless dissociation by two. Third, the alkali cell has comparatively a small mass of electrolyte to draw upon. In all, the question of electrolyte mass comes to this: that in the alkali battery we multiply a serious trouble by a factor of three or four and then halve the means of getting around it.

Another trouble arising from refilling, is the quality of the water used. In large commercial operation or in laboratory work, where distilled water can be gotten, this is not serious, but with small users, where the hydrant is the common source of supply, it is often the means of putting into the electrolyte some active agent that eventually disintegrates the plates. Obviously, the lead battery has the advantage.

Again, the acid electrolyte is commercially the better for the ease of handling. The advantage will be overcome if the alkali battery will need no overhauling, but for the ordinary run of events, overturned cells, over-filled cells, handling of old plates, moisture from gassing in overcharge, for the numerous contingencies arising in actual work, there can be no question that alkali is worse than acid for woodwork, clothes, and hands. Acid does not creep—alkali both creeps and turns to carbonate. The advantage sometimes claimed for the alkali simply upon the ground of its not changing is a little hard to understand. There is, on the face of it, no reason why the electrolyte should not change as well as the plates; in fact, a battery with unchanging electrodes and changing electrolyte would in many ways be better than its opposite. For instance, the change of electrolyte density is, in the lead cell, a very useful and needed means of determining the state of charge and discharge.

Adaptability to different uses of one or the other battery will be determined by utility and cost. For central station work, which at present takes about 75 per cent of the battery output, the position of the lead cell seems secure. Its low first cost, low internal resistance, high voltage, and general efficiency more than overbalance the deterioration, which is a matter of careful figuring; in so many years so many plates must be manufactured and installed to keep a given battery in good condition; as an offset, so many pounds of scrap lead and so many pounds of battery mud are returned. The renewals ordinarily mean no interruption of work and not much expense in installing.

For lighter service, particularly for electric wagons, where watt efficiency and cost are to some extent subordinate to convenience, the choice will depend largely upon capacity and reliability.

Data is wanting upon the capacity of the alkali cell per unit of volume and weight, but it seems reasonably certain that neither will be far different from that of the pasted lead battery. As for reliability, which must not be mistaken for long life, data on the alkali cell is again wanting and must be wanting until the cells are put into ordinary service, with ordinary care and attention. It seems certain that the necessity for frequent refilling will mean serious trouble in the way of low cells and irregularity of working, while the problem of the alkali electrolyte and excessive gassing will need most careful consideration.

The commercial life of lead plates, in truck or cab service is about 15,000 to 20,000 miles for negatives, 12,000 miles for Planté positives, and 6,000 miles for pasted positives. In other words, a four or five-ton truck running 20 miles per day for 300 days in a year requires new positives once in a year or once in two years, according to the type of plate used, the choice of one or the other being determined by the character of service and length of run desired. Cabs and lighter wagons have about the same life, with a capacity of 40 to 100 miles on one charge.

Work done under these conditions, actual work reduced to dollars and cents, has shown that the electric wagon gives better city service than can be obtained from gasoline, steam, or horse. A better battery, either an improvement on the old one or a better new one, would control practically all city traffic not on rails.—The Automobile Review and Automobile News.

THEORY OF THE COHERER.

IN a lecture delivered before the Association of Ingénieurs Electriciens, Mr. O. De Bast explained the theory of the action of the coherer as developed by Mr. S. Fernandez-Gimenez. Given two bodies isolated in space, a charge imparted to one will induce an equal, but opposite charge on the second, if the latter be connected to the earth, the two forming a condenser. If there are in the neighborhood of the two bodies other bodies also connected to the earth, some of the lines of force set up by the charged body will pass to these. In all cases, however, the sum of the induced charges will be equal to that on the first body. If there are in the neighborhood of the system bodies not connected to the earth, these will simply cause a deflection of the lines of force, without reducing the induced charge. If the charge is an alternating one, the induced charge will also be alternating. If, now, in the earthing connection of the plate upon which the charge is induced a condenser of small capacity is introduced, the potential across this may be sufficient to cause its two charges to reunite across a suitable spark-gap. If the induced charge is small the capacity of this condenser must also be small, but it can always be made so by connecting a sufficient number of condensers in series. The discharge of these condensers will be oscillatory, but the period will be independent of that of the inducing charge. A coherer may be considered as a group of very small condensers arranged in series parallel, each pair of particles being separated by a thin coating of oxide, and forming opposite sides of an elementary condenser, the capacity of the whole being very small. The two antennæ may be considered as the opposite plates of a primary condenser. If a coherer is connected in series with the receiving antenna, and this latter be charged by induction, the difference of potential across the coherer may be sufficient to cause a spark to pass. In this case, however, the spark passes from particle to particle, tearing off at each gap a small part of the oxide coating, and bringing the particles into metallic contact. This action allows the current to flow in a suitably arranged local circuit. A slight tap on the coherer displaces the particles, breaking the metallic connection. Experimental researches based upon this theory seem to verify it. In this study the antennæ are considered as two sides of a static condenser, and the coherer as a means of obtaining considerable difference of potential, as well as an instrument for indicating this. The induction coil at the transmitting station allows an alternating charge to be imparted to one side of the condenser.—Bulletin des Ingénieurs Electriciens.

CONTEMPORARY ELECTRICAL SCIENCE.*

TELEPHONE VIBRATIONS.—R. Kempf-Hartmann publishes the results of a lengthy investigation of the vibration of telephone membranes, undertaken with a view to clearing up the disturbing noises attending the telephonic transmission of sound. The telephone problem is that of receiving a series of variations of density of the air at one point and faithfully reproducing them at another point. The practical solution is somewhat indirect, and consists in converting the changes of density into vibrations of an elastic disk, and reproducing them by electromagnetic means. This introduces complications due to the natural vibration of the disk such as would not exist if the transmitter were, say, a small gas jet, whose variations with the pressure were transmitted with the aid of a selenium cell. The author recorded the vibrations of a telephone diaphragm by means of a mirror stuck on to it, and an arrangement of an arc light, a point diaphragm, a system of lenses, and a revolving cylinder of sensitive film. The first point investigated was whether a note received by the diaphragm gives rise to a corresponding series of vibrations of the diaphragm at once, or whether the vibration only gradually fell in with that of the air. The photographic traces of a tuning fork note show that the reaction is practically instantaneous, the "period of latency" not exceeding 0.0005 second. The maximum amplitude is attained as soon as two full periods have passed through. After that the curve for a constant sound remains remarkably constant. When the note ceases the proper vibration of the diaphragm persists long enough to be seen and even heard, but it is greatly damped by a rubber plug attached to the center of the diaphragm. It also appears that the overtones which produce the rattling and clattering noises in the telephone are the more prominent the greater the amplitude of the diaphragm. This is contrary to what happens in reeds and strings, where the fundamental note becomes more prominent the greater the force with which the note is sounded. As regards the comparative sensitiveness of the eye and ear, the author mentions that, generally speaking, the records show a sound whenever a sound is heard, and vice versa. In traces of complete words, however, the records show a number of details which are quite beyond the perception of the ear. He gives some interesting curves representing vowels and consonants, which are reproduced with the finest detail.—R. Kempf-Hartmann, Ann. der Physik, No. 7, 1902.

A MICRO-BALANCE.—An approximation to within 1 per cent is difficult to obtain when weighing a body of about 1 milligramme with a chemical balance. E. Salvioni, therefore, uses an apparatus, which he calls a "micro-balance," for determining weights of the order of 0.001 milligramme. It consists essentially of a horizontal thread of glass, fixed at one end. The body to be weighed is mounted on the other end, and the flexure of the thread is measured by a micrometer microscope. A simple calculation shows that a glass thread of circular section, about 0.15 millimeter in diameter and 10 centimeters long, can support 100 milligrammes without breaking, and can serve for finding its weight within 0.001 milligramme with an optical enlargement of 100 times. The objects to be weighed are suspended from the end by a carrier attached to a thin glass fiber, which also carries a spider's thread to serve as a reading mark. The evils attending elastic fatigue are eliminated by keeping the thread constantly bent when not in use. The weights used for control are platinum wires above 5 milligrammes, and silk threads for smaller weights. To avoid hygroscopic action, it is best to operate in dry air and in closed vessels.—E. Salvioni, Nuovo Cimento, May, 1902.

ELECTRICAL PROPERTIES OF DIAMOND.—Density, hardness, and quantitative combination with oxygen are at present accepted as the necessary and sufficient distinguishing qualities of diamond. A. Artom proposes to add certain electrical properties, some of which also happen to be very characteristic. The resistivity of diamond is about the same as that of the ordinary glass, the values obtained by the author ranging from 0.2 to 1.3 $\times$ 10^{12} (ohm-cm.) It is remarkable that graphite, the allotropic form of carbon into which the diamond is transformed at a high temperature, should possess a conductivity some 10^{15} times as high. Under the action of Röntgen rays, the conductivity of diamond is doubled, but the original resistance is restored at once on removing the rays. Like ice, diamond possesses a dielectric constant largely in excess of the value warranted by its refractive index. Theoretically, it should be about 7, but in reality it is anything from 10 to 17. The author takes this as an indication that the diamond, like ice, retains the dielectric constant it had in a previous liquid state. Possibly, also, certain hydrocarbons like CH_2 CH_2 may be present in small quantities to raise the dielectric constant. Diamond shows residual polarization, and consequent electric hysteresis. It is feebly paramagnetic and pyro-electric.—A. Artom, Accad. Sc. Torino, Atti., 1902.

RADIO-ACTIVE RAIN.—Since a negatively-charged body exposed in the atmosphere becomes radio-active, apparently indicating the presence of some radio-active substance in the atmosphere, it occurred to C. T. R. Wilson to test whether any of this radio-active substance is carried down in rain. He boiled down freshly-fallen rain to dryness, and found a radio-active residue. The radio-activity was detected by means of the increase in the ionization of the air within a small vessel, of which the top or bottom was of thin aluminium or gold leaf, the other walls being of brass. The vessel contained a gold leaf attached to a brass wire, the two forming a leaking system of small capacity. The rain was evaporated in a platinum bowl, which was cooled by floating on water, and then placed above or below the ionization apparatus. The radio-active layer was strong enough to increase the rate of leakage to four or five times its normal value. Filtering the rain-water produced no effect. The radio-activity rapidly disappears, falling over 50 per cent in the first hour. From the evaporation of distilled water or tap-water or of rain-water which had stood for

* Compiled by E. E. Fournier d'Albe in the Electrician.

some hours no radio-activity was obtained. Nor did such water yield a radio-active residue when exposed for some hours in the open air.—C. T. R. Wilson, Proc. Cambridge Phil. Soc., Easter, 1902.

SPECIMENS OF AMERICAN-INDIAN MEDICAL PRACTICE.

WHATEVER one may say of Indian medicine men, they must as a class be given credit for earnestness and a superior sort of intelligence; and while it must be admitted that some of their practices and methods are strongly flavored with a tinge of Christian science and allied fakes, their prayers are used merely to add to the efficacy of the drugs which they administer, or the massaging which they practise, and are the natural result of superstition inborn generation after generation. The medicine man occupies a unique position in his tribe. His work is not strictly confined to the practice of medicine; he is a man of consequence, and his fastings and prayers and his self-denials make him, in the eyes of his people, a man who is in close communion with the spirits of the air and the waters and the elements.

The real medicine man, the typical product of the plains of the West, such, for instance, as War Bonnet himself, spends years in study and preparation; and in gathering his herbs and roots and fossils, he subjects himself to privation and suffering and solitude. When his medicine bag needs replenishing. the medicine man strips himself and naked goes forth into the foot hills and mountains. For seven days he neither eats nor drinks nor sleeps. Back and forth he wanders, praying to the Great Spirit and searching for what he is in need of. When he returns to his tribe he is a sorry spectacle, gaunt, hollow-eyed and dirty; yet he has his herbs and roots and his bones, and they are doubly efficacious because of the long fasting and the unending prayers.

As sanitary officer of the Chicago exposition, it was a part of my duty to watch over the health and living methods of the various natives on the Midway. I visited each village several times a day. While I was tolerated in the Philippines, welcomed in Venice, damned in Damascus and cursed in Cairo, the Indians looked upon me by virtue of my office as a chief, and treated me as such, respecting and obeying orders regarding health matters. Not many days had passed before it was generally understood that I was a medicine man, and the medicine man of the tribes, War Bonnet, a grave and dignified old Indian, sought me out and through an interpreter, begged in the flowery language of the Sioux, that I honor him by a visit to his tepee.

I wanted to see as much of Indian medicine as possible and to that end had all sick Indians report to me each morning. For the first few weeks there was nothing more serious than colds, headaches and indigestion. Then Rocky Bear, a sub-chief, broke his leg and was sent to a city hospital. He was properly cared for, but the next day demanded to be returned to his tribe and was brought back. The same night when I visited him I found the dressing had been removed and that War Bonnet was in attendance. The interpreter told me I could not stay because the medicine man was working. Rocky Bear grunted "How" and held out his hand, and War Bonnet, speaking in Sioux to the interpreter, said I was a medicine man and his brother and should remain; but, that Rocky Bear wanted Indian medicine. War Bonnet's medicine case—a buckskin bag—was on the ground beside the fire. It was filled with smaller bags containing coarse and fine powders, dried roots and leaves, and some chunks of what looked like suet. There was the back of a turtle shell, a tin can of fat, and the skull, with beak attached, of a red-head woodpecker.

In sign talk Rocky Bear informed me that he had had much pain in his leg and that he had not slept; that War Bonnet was going to take all the pain away and put him to sleep. The medicine man had a pan of coals by his side. Over this he warmed his hands after smearing the palms with grease, which I afterward learned was bear fat; he dipped his finger into a little bag containing a greenish powder and mixed it with the grease, then into a bag of white powder which he also mixed up. With this he rubbed the broken leg, carefully, gently, all the while chanting a weird but not unmusical song. Occasionally he would change the powders. In ten or fifteen minutes Rocky Bear said his pain was gone. In half an hour he was drowsy, and before we left a short time after, he was asleep. Before leaving the tepee War Bonnet bound up the leg with a splint and thongs.

I could never get a very definite idea regarding the character of his powders other than that he made them from roots, herbs and portions of animals and birds. Twice a day he treated Rocky Bear, and when the latter went back to the reservation he had a pretty good leg. There was a continued use of the splint and I must say for War Bonnet that he put that leg up in a well-approved fashion.

In explaining the treatment to me afterward, he said that he used the splint to keep the bones together, and that he took it off and rubbed the leg to let the blood get through and to keep the leg alive, adding wisely that if the splint was left on, the leg would die.

The Indian does not want pills or tablets. He wants liquid medicine and he wants it so he can taste it and remember the taste after he has taken it. The worse it is the better he likes it.

When it became an assured fact that War Bonnet had confidence in his "white brother," I ventured to ask questions concerning his practice and the material he used. There were some things which he could not or would not tell me of; for example, the process he used to produce sleep. He claimed to be able to keep a person asleep for a week without ill-effect and the interpreters told me they had seen such things done many times. The woodpecker skull and beak he used to mix medicines in the turtle shell. There is supposed to be some sort of special virtue in the woodpecker when it happens to be a red head, not only in medicine but in the making of charms and ornaments. The bear grease was used merely as a base for his ointments, the powders added being lizards, fish, various parts of animals and birds, pulverized leaves, roots and flowers. There was one coarse and grayish white, which was more highly prized than all the rest of the stuff which War Bonnet carried. This was said to be the bones of an animal "like the elephant, only bigger, much bigger," as the interpreter put it. These bones are found deep down in the ground in the foot hills and the location is known only to the medicine men of the different tribes. There was, too, a paste which was strangely like ichthyol in odor and color.

When Baby Johnny Ghost Dog died of an inspiration pneumonia, brought on by the inhalation of grains of partially cooked rice, he was in the exposition hospital. War Bonnet had not treated him at all and took advantage of that fact to impress on the minds of the tribe the presence of an evil spirit on the grounds—a spirit which only he could exorcise. A few days later Mary Pretty Boy, a three-year-old child, was seized with convulsions. I was in the camp at the time and one of the interpreters called me. In the tepee the father sat holding the child across his knee. The mother had run away in a panic of fright when the baby was taken sick and a neighbor had gone to hunt up War Bonnet. The father refused to allow me to treat the child, saying only War Bonnet should give medicine. I said the baby must be taken to the hospital.

"No," said Pretty Boy. "The evil spirit lives there. It is death for babies to go there, for the evil spirit killed Johnny Ghost Dog. War Bonnet will make her well." His confidence in the medicine man was sublime, his faith childlike.

Outside, mingled with the crashing of the band and the crack of rifles in the sham battle could be heard the voice of Seven Rabbits, the spokesman of the tribe—a sort of town crier—calling for War Bonnet. His voice, usually a drawling monotone, now rose and fell and the words were snapped out. Then the soft patter of moccasined feet, the flap of the tepee was brushed aside and War Bonnet tumbled in—dignified in spite of his haste—his medicine bag in his hands. This he cast on the ground; an Indian untied it and spread the various little bags in a circle, the sacred bird skull in the center with the turtle shell. And then I witnessed the practice of real Indian medicine as it has been practised from time immemorial among the Redmen of the plains, and handed down from father to son generation after generation. As soon as he entered the tepee, War Bonnet flung himself on his knees before the child and taking its hanging head in his hands uttered a weird cry, half snarl, half grunt, and placing his lips to the child's mouth sucked from its throat mucus which he spat upon the ground. He tore off its clothing; he thumped its chest; he sucked at its throat and chest and the back of its neck, raising great blotches of red flesh dotted full of little pinpoint specks of blood. A convulsion seized the child still lying across its father's knees, and intoning a chant of most musical rhythm the medicine man dabbed powders on its breast and abdomen and poured cold water over the child from head to foot.

"He'll kill the child," I said to the interpreter.

"If he dies, War Bonnet will wake him up again," said the Indian simply. (To the Indian everything is "him.")

"Send her to the hospital," I pleaded.

"No, he will die there," was the reply, final and decisive.

Powders and ointments were rubbed on the child's body; her teeth were tightly clenched and a spoon was used to pry open the jaws. Chewing up a mouthful of what appeared to be dried leaves over which he had sprinkled one of his powders, War Bonnet blew the mass into the child's throat. Strange signs were made on the baby's chest with the bird skull dipped into a paste and then began the heating of the hands over the coals and the mixing of powders and grease, the rubbing, the chanting, the sucking at the throat, the blowing on the closed eyelids, and all the time the child lay dying across the lap of her father whose face, as expressionless as a piece of stone, showed no sign of sorrow or concern. One could not help marvel at the apparent disregard. In the end the child died and I sat on one side of the tepee with War Bonnet and witnessed the most impressive ceremony I have ever seen.

With its last fluttering breath the child's body slumped down into the hollow of its father's lap. Its mother had not returned and a half dozen squaws stood by silent and motionless, waiting for the end. As soon as it was apparent that death had entered the tepee, Pretty Boy looked up and thanked War Bonnet for what he had done. This is never overlooked by an Indian; he is appreciative and in this respect he is the superior of his civilized white brothers. After expressing his gratitude to the medicine man, Pretty Boy let his hair down and wept, hugging his dead child close to his breast and talking to it in the Sioux language, crooning and caressing. Sobs shook him and great tears splashed down on the little bronze body. Everyone of the squaws rushed out into the camp and crying out that Mary Pretty Boy was dead, rounded up their own children and sent them skurrying to their tepees for an evil spirit was about. Then they all returned to Pretty Boy's tepee and throwing their blankets over their heads began to mourn. They howled and chanted and teetered up and down on their toes and wept in the death dance of the squaws. They kept this up for an hour or more until a lone, forlorn squaw crawled into the tepee like a whipped dog, her face sorrow drawn and tear stained; and creeping, creeping, creeping, she came to the sorrow stricken Indian sitting there with his dead baby in his arms, and kissed her lost child. The squaws left one by one, followed by War Bonnet and his "white brother," and save for the sobbing cries of the mother returned to her desolate home, there was silence in the camp. I wondered how the medicine man would explain his failure to save the child and learned that he fell back on the all-powerful evil spirit, and that his reputation suffered not at all.

I had passed over as unworthy of investigation or even consideration, the stories I had heard of the miracle of raising the dead by medicine men and in fact had forgotten all about it, until one day I found myself suddenly famous among the Indians as a wonder worker fit to rank with the best of their medicine men. The squaw of Blue Horse tumbled over in a faint one afternoon and she was carried into her tepee. The Indians said she was dead. I applied restoratives and in a little while she was all right. Now, Blue Horse is a big civil chief in the Sioux Nation, and his wife is of some consequence in Sioux society. So when the Indians saw her come back to life after apparent death, they gave me credit for having worked a miracle. Blue Horse himself believed it and circulated the story. This simple event explained to me the "marvelous resurrections" by medicine men.—From an article by Nelson W. Wilson, M. D., in Buffalo Medical Journal.

BREATHING LIQUID OXYGEN.

AT the recent International Aeronautical Congress at Berlin, May 22 to 24, 1902, Prof. Cailletet, of Paris, showed his apparatus for breathing oxygen at great altitudes. The chief disadvantage of the methods hitherto employed in ballooning consists in the fact that the gas is carried in a compressed state, whereby, since at each breath several liters of gas are used, strong and heavy receptacles are required. If, on the contrary, liquefied oxygen is taken, which has almost the same density as water, proportionately small vessels are needed, and these can be given any convenient form. M. Cailletet employs the ordinary pear-shaped glass flask, having double walls separated by an air space and silvered externally, in order that the liquid oxygen in it shall be protected from the conduction of external heat and from solar radiation, and thereby kept in a liquid condition. By working a rubber bulb the liquid gas is driven through a narrow tube, connected with the interior of the flask, into a system of tubes having a larger amount of surface. Here it evaporates and in a gaseous state passes through flexible tubes into a caoutchouc reservoir that hangs from the ring of the balloon and is protected by a net against oursting. Thence the gas, after it has been mixed with atmospheric air, passes to the breathing mask. The mask is fastened by elastic bands in front of the face, so that the aeronaut is always forced to breathe oxygenized air. At the lower part of this mask there is an outlet tube for the expired gases, which is ingeniously arranged so that during inspiration the lower end is automatically closed, and, in order that the expired vapor may not be frozen after condensation and so stop up the tube, its lower end is placed under the clothing.

In the discussion Dr. von Schrötter reminded his hearers that it was Paul Bert who had first called attention to the fact that the want of oxygen was the cause of the pathological symptoms which man showed in rarefied air. In regard to the opinion held by some Alpinists as to the inefficiency of oxygen, Prof. Zuntz remarked that the exhaustion of the heart, which was not counteracted by breathing oxygen, gives rise to the same symptoms as does the lack of oxygen.—Monthly Weather Review.

AN ADVERSE VIEW OF THE METRIC SYSTEM.

LET us remember that the English system of weights and measures is the result of the natural selection of the great practical, mechanical and industrial race of mankind, developed by, and meeting the needs of, the creative artisan, working with the measuring rod in one hand, and the saw, the hammer or the chisel in the other. The metric system, on the other hand, is the scientifically beautiful conception of a coterie of savants who probably never in their lives had occasion to make a single practical measurement.

It was considered of more importance that the system should derive an august parentage from the arc of a terrestrial meridian—preferably that of Paris—than that it should be the adaptation of means to a practical end. Hence the meter was taken as the unit. If the artisan needs something smaller, let him take the thousandth part of the unit and call it a millimeter; if the surveyor needs something larger, let him take it a thousand fold and call it a kilometer; but never let either lose sight of the unit; never let him relax his hold on the meridian of Paris, right or wrong. The charge is constantly brought against the English system that it is complicated. Taking linear measurements, the partisans of the metric system tell us we have the inch, the foot, the yard, the fathom and the mile. How confusing, they say. Why have several tools, instead of only one?

The answer is, because we have several different kinds of work to do, and we need a convenient tool for each. The handicraftsman uses the inch, which he subdivides into halves, quarters, eighths, etc., according to the natural method of successive halving. He will run up to 100 and more inches before giving up his unit for a larger one. The builder and architect needs a larger unit, and takes the foot, which he subdivides, usually duodecimally into inches. The sportsman finds the yard, which he can measure by stepping, the most natural and convenient. The line engineer takes the "station" of 100 feet as his unit, and for long distances between localities the general public adopt the mile. All, be it noted, follow the instinctive tendency of the practical man to use multiples of smaller units rather than divisions of larger ones.

"But," the metric advocates reply, "we do the same. We use the millimeter and centimeter for small measurements and the meter and kilometer for larger ones." So they do, but with this radical difference—they use exclusively decimal divisions and multiples, irrespective of whether or not the outcome is the convenient unit sought after.

In the English system the convenient unit is secured, irrespective of the ratio which it bears to the one above or below it, provided that some simple ratio does connect them. One-twelfth of the foot is more convenient for small measurements than one-tenth, which is rather too large. Three times the foot is more convenient for many uses than ten times the foot, hence the yard; and 5,280 times the foot is just about right for the unit of geographical measurements; hence the mile.

Moreover, we freely use decimals of all the above units when it becomes more convenient to do so. As already stated, the line or railway engineer uses stations of 100 feet, and expresses his "plusses" in feet and decimals of a foot. Leveling rods are graduated to feet, tenths and hundredths, and are read to thousandths by means of a vernier. Engineers' draughting scales are divided into inches and tenths, twentieths and other even multiples of ten.

In land measure, areas, whether measured with the 100-foot or 66-foot chain, are now always expressed in acres and decimals of an acre, and so on. In a word, throughout the whole system the convenience, and, consequently, the accuracy, of the one actually making the measurements are consulted, rather than of the computer who only figures them up, the fact being recognized that there is not, and cannot be, any single unit which is equally convenient for all uses.

The writer believes that this is the true view to take of the subject. He believes that the more it is studied, with the measuring rule in hand, the more it will become apparent that the English system of linear measurements is wonderfully adapted by its variety to the various uses to which it is put by the dominant industrial race that invented it. No doubt it involves some inconvenience in the office; but it is typical of the spirit of its inventors that this defect is lightly considered if it is the price paid for greater convenience in practical applications.—E. Sherman Gould, in Cassier's Magazine.

When Soap is Made from the lye obtained by leaching wood ashes, it is soft by nature, says the Druggists' Circular and Chemical Gazette. The hardening process carried out in domestic practice, namely, the addition of common salt, really converts it into another kind of soap. It is in the first instance a potash, or, correctly, potassa soap, which remains soft. By the addition of common salt (chloride of sodium) it is converted into soda soap, the potassium being displaced, and being thrown away in the liquid left after the soda soap is separated.

Hard soaps are made commercially by the direct use of caustic soda, which is to manufacturers the most economical way by far.

THE MANUFACTURE OF OLEOMARGARINE.

OLEOMARGARINE was first manufactured in France. In 1869 the French war office, at the instance of Napoleon III., who was desirous of discovering a substitute for butter that would keep longer and also increase the dietary of the poor, offered a prize for the best substitute, which was won by M. Mége-Mouries, a Parisian chemist. After a series of observations and experiments, Mége-Mouries was persuaded that the butter fat contained in milk was absorbed from the animal tissues of the cow, and his attention was then directed to the discovery of a process that would separate from beef fat the oil similar to that in milk. The method finally devised by him for the manufacture of oleo oil (called then oleomargarine or oleomargarine oil) was to heat finely minced beef fat with water, carbonate of potash, and small fragments of fresh stomachs of sheep, to a temperature of about 115 degrees Fahrenheit. The influence of the heat, together with the pepsin contained in the sheep's stomach, separated the fat from the cellular tissue. This fatty matter was then removed and when cool was subjected to hydraulic pressure sufficient to separate the stearin. The oleo oil was then churned with milk and water in the proportion of 10 pounds of oleo oil to 4 pounds of milk and 3 pints of water. The resulting compound was washed and declared ready for use.*

The industry was early introduced into the United States, but statistics of its manufacture prior to 1886 are unreliable. In that year Congress passed an act regulating its manufacture and imposing a tax of 2 cents a pound on the product. From that date more exact information is obtainable. In 1887 there were 21,513,537 pounds made, and the present report shows a product of nearly five times that amount.

In the manufacture of oleomargarine so much depends on the handling of the constituent oils and the manipulation of the temperatures by which they are surrounded throughout the different stages of the process, that equipment for live steam, ice water, and refrigeration is the indispensable requisite of every establishment. Aside from this, the equipment consists principally of the machinery of power, melting tanks, mixing tanks, milk receptacles, churns, and machine butter workers. The butter workers are such as are used in creameries throughout the United States. In some factories the churns are similar to those used in creameries, but oftener they are large, upright, jacketed caldrons in which the milk and color are mixed with the melted oils by a violent churning or stirring produced by revolving or rotating agitators inside. By the introduction of steam into the jacket, the operator controls the temperature and the degree of liquefaction until the churning process is complete. By the same means any considerable quantity of oleomargarine is prevented from congealing on the side of the churn while the contents are being drawn off. The equipment is generally of American manufacture. Only two factories visited by the writer were supplied with foreign machinery, which was imported from the centers of oleomargarine manufacture in Europe.

The number and character of the ingredients of oleomargarine make them susceptible of almost an infinite number of combinations, and each manufacturer has his own working formula. So much depends on the handling of the oils and the regulation of temperature surrounding them at each successive step, that different manufacturers using the same quality of ingredients in similar combination will secure vastly different results. A formula for each of three distinct grades of oleomargarine, of general manufacture, is given below

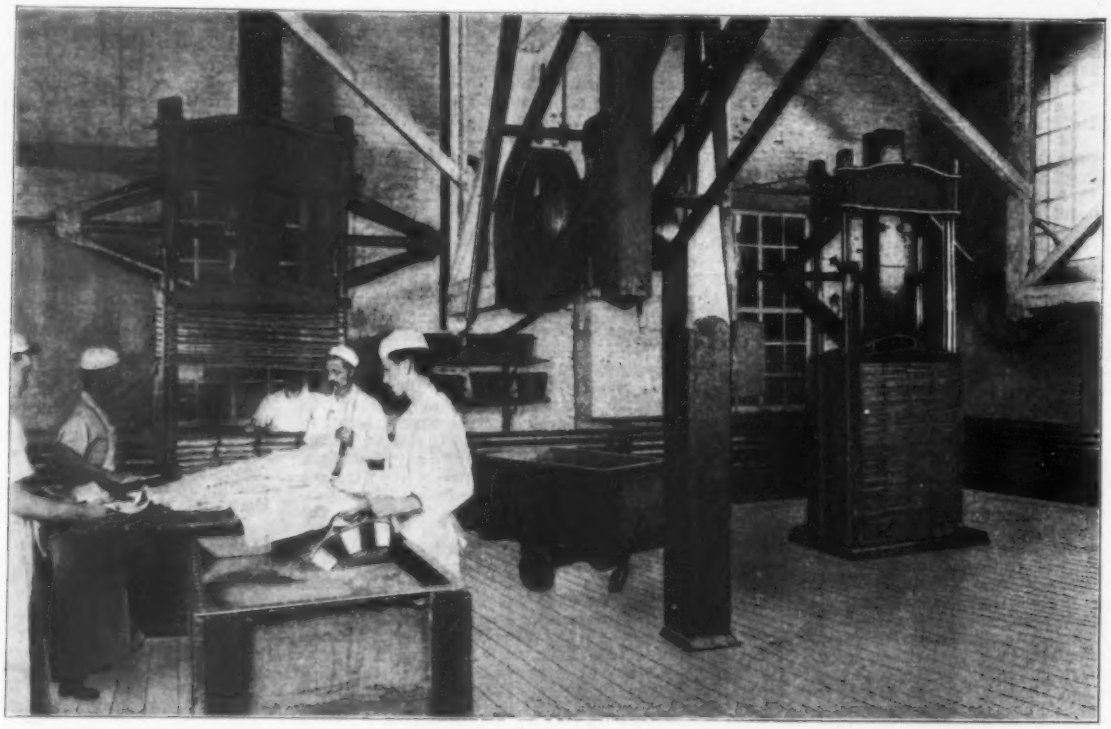


FIG. 1.—SEPARATING OLEO OIL FROM THE STEARIN OF THE FAT BY PRESSURE.

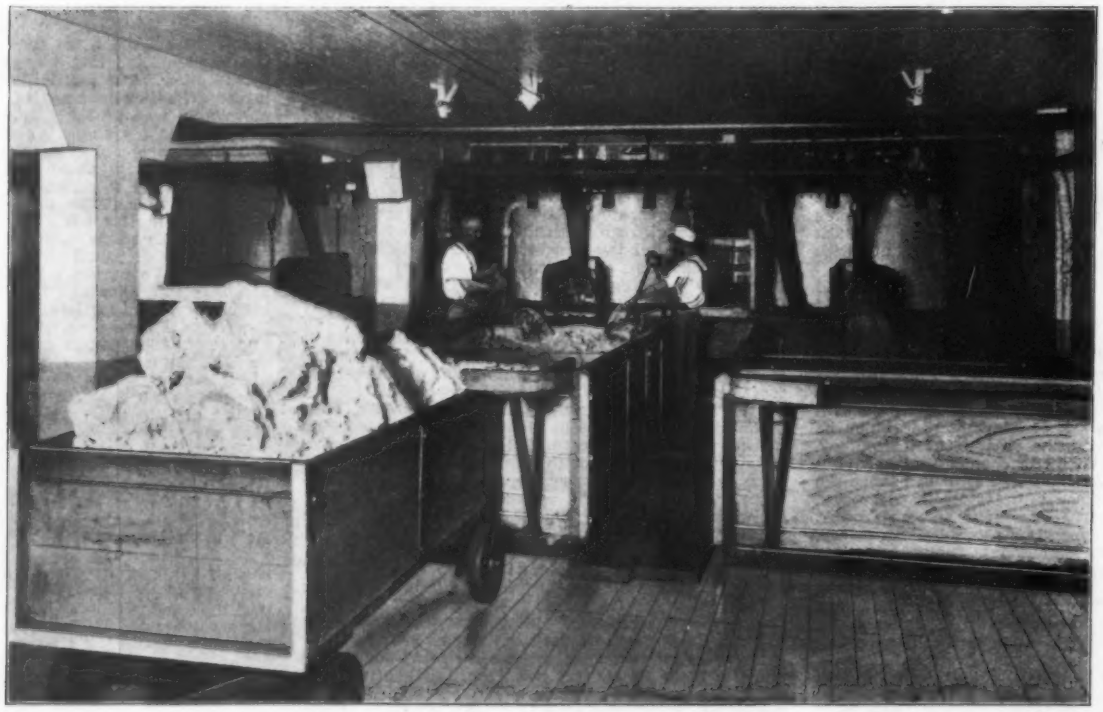


FIG. 2.—CHURNING OLEOMARGARINE.

* Appleton's Annual Cyclopædia, 1882; also Universal Cyclopædia, 1900, vol. 2, page 253.

to show the use of different ingredients and their variation in quantity.

Formula 1.—Cheap Grade.

	Pounds
Oleo oil	495
Neutral lard	265
Cottonseed oil	315
Milk	255
Salt	120
Color	1¼
Total	1,451¼

will produce from 1,265 to 1,300 pounds of oleomargarine.

Practically all the oleomargarine manufactured in the United States is made by the simple process of churning a melted mixture of oleo oil and neutral lard with milk, cream, or melted butter to give it the butter flavor, and coloring matter to give it any desired shade of yellow in semblance of butter. In the cheap grades cottonseed oil is often substituted for a portion of oleo oil and neutral lard, but never to the total exclusion of either. After the churning process the whole is salted and put upon the market in a variety of forms, as demanded by the various classes of consumers. The different forms in which it is packed for market are well shown by the following extract from a circular of information issued by one of the large manufacturers:

"Our Butterine is packed as follows:

"Solids in 10, 20, 25, 30, 40, 50, and 60 pound tubs; also in 25, 28, and 50 pound record packages (tin-lined).

1-pound bricks in 10, 28, 30, 48, and 60 pound cases; also 48-pound tubs.

2-pound bricks in 30, 48, and 54 pound cases.

3-pound bricks in 54-pound cases.

5-pound bricks in 50-pound cases.

1-pound rolls in 42, 56, and 62-pound tubs; also in 10 and 50-pound cases.

1-pound country rolls in 37 and 50-pound tubs and 50-pound cases.

1-pound long rolls in 42 and 62-pound tubs.

1-pound prints in 37 and 50-pound tubs; also 50 and 60-pound cases.

2-pound rolls in 32, 52, and 62-pound tubs; also 10 and 56-pound cases.

2-pound rolls in 32, 52, and 62-pound tubs; also 10 and 56-pound cases.

2-pound country rolls in 52-pound tubs and 50-pound cases.

1, 2, and 3-pound rolls, assorted, in 62-pound tubs.

3-pound rolls in 54-pound cases.

5-pound rolls in 60-pound cases.

9½-pound rolls in 57-pound cases."

Cottonseed oil is used as a partial substitute for oleo oil and neutral lard. It never fully replaces either, but is added to some combination of those two ingredients to cheapen the finished product. It is a liquid within the range of temperature to which butter is exposed, and its use is therefore limited to such a proportion in any formula as will not soften the product beyond the usual consistency of butter. Its use would doubtless increase largely were it not for the fact that no process has been discovered that will take away its characteristic flavor. To make a high-grade oleomargarine it is absolutely essential that all its constituent oils respond fully to the neutralizing treatment by which their characteristic odors and flavors are removed, so that they will take on the flavor of butter from the aromatic principles of the milk or cream with which they are churned. Cottonseed oil, when forming any considerable proportion of oleomargarine, betrays its presence, and those manufacturers making a specialty of high-class table products have discontinued its use altogether.

Oleo oil is obtained from beef fat by the processes of settling, crystallization, and pressure, which separate it from the stearin and the fiber. Its manufacture is more widely distributed than that of neutral lard, but is principally confined to the large packing houses, which supply their own oleomargarine departments, and also the independent manufacturers and the export trade. By independent manufacturers is meant those who produce oleomargarine exclusively, in contradistinction to those who subordinate it to slaughtering and meat packing. None of the independent manufacturers make their own oleo oil.

After the animal is slaughtered the fat is removed and placed in a vat of warm water, where it is thor-

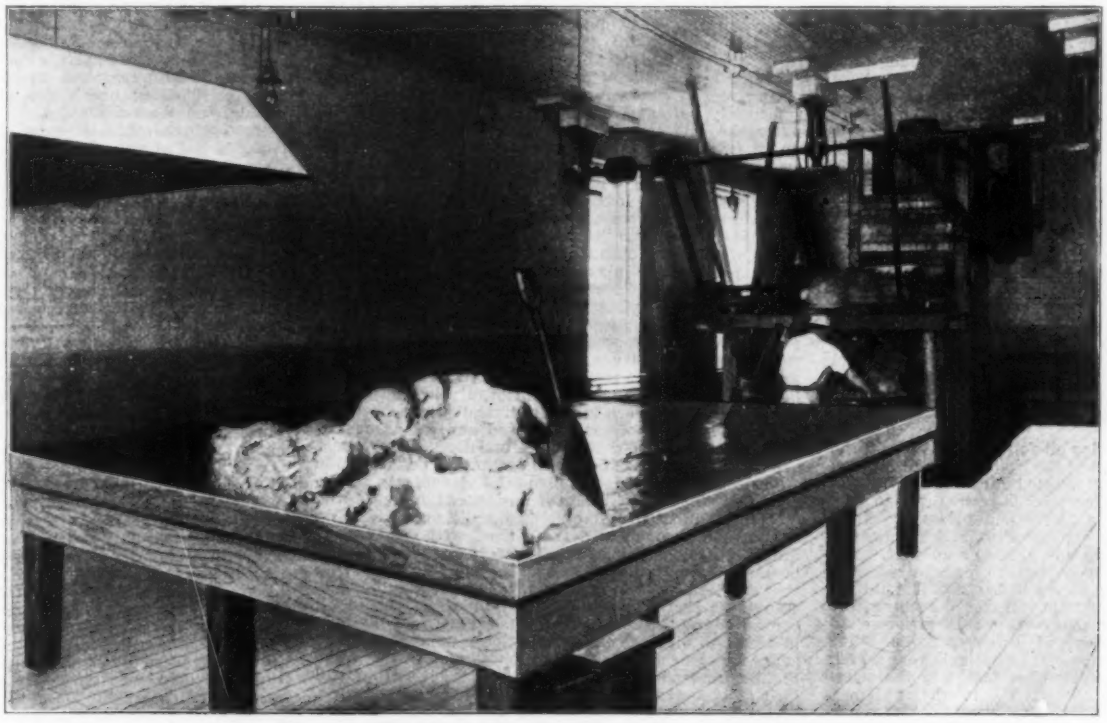


FIG. 3.—THE "WORKING" AND SALTING PROCESS AFTER CHURNING AND TEMPERING.

FIG. 4.—PACKING OLEOMARGARINE FOR MARKET.

Formula 2.—Medium High Grade.

	Pounds
Oleo oil	315
Neutral lard	500
Cream	280
Milk	280
Salt	120
Color	1½
Total	1,496½

will produce from 1,050 to 1,080 pounds of oleomargarine.

Formula 3.—High Grade.

	Pounds
Oleo oil	100
Neutral lard	130
Butter	95
Salt	32
Color	½
Total	

will produce about 352

oughly washed to remove blood and adhering impurities. It is then chilled and hardened with a bath of ice water, after which it is finely comminuted by cutting machines and melted in steam jacketed caldrons at a temperature of about 160 degrees Fahrenheit. Slowly revolving agitators keep the fat moving until the melting process is complete, when the whole is allowed to settle. The settling process is accelerated by the addition of salt, which is scattered over the entire surface of the liquid and settles the fiber or "scrap" to the bottom. After the first settling, the clear oil is carefully siphoned to a second series of jacketed caldrons, usually on the floor below, where more salt is added, and the temperature controlled until a second settling is completed. This demembranized fat is now siphoned into mounted vats and allowed to stand from three to five days in a temperature favorable to the crystallization of the stearin, a part of which forms a crust over the top and the remainder settles to the bottom, leaving the clear oil between. It is a common phenomenon in the crystallization of various substances whose specific gravity is not greatly in excess of the mother liquid that, cooling first at the top, a portion of the substance which is being crystallized out forms a crust over the surface and the remaining portion is precipitated. When the vats have stood the required time the crust is broken into fine particles and the whole is given a thorough mechanical mixing which leaves it of a mushy consistency. It is then wheeled to a revolving table surrounded by skilled workmen who wrap the mixture into small packages with canvas cloths—each containing about three pounds—which are built into the presses. The oleo oil is then separated by great pressure, slowly and gradually applied, and flows from the presses into a large receiving tank on the floor below, from which it is piped to the oleomargarine department or is drawn into new oak tierces and allowed to harden in preparation for shipment to independent manufacturers or for export. Fig. 1 shows two presses, one filled and the other in process of being filled.

All manufacturers of oleo oil follow substantially the method above described, but the system of grading and the character of the fat selected differ greatly. The number of grades manufactured is from three to five, and, when the market is active and prices are high, about all the fat taken in slaughtering, both from cattle and sheep, is worked into one grade or another. The oil made from sheep fat cannot be neutralized, and retains the characteristic odor and flavor of the animal to such degree as to be unfit for the oleomargarine demanded in American markets. It is exported to Europe, where there is demand for cheaper oils. With the beef fats the character of the animal from which they are taken is the most potent factor in the selection. Some manufacturers work into their highest grade of oleo oil practically all the fat taken from a good steer, and make one or two lower grades from the fat of cows and "canners." Other manufacturers make their highest grade from the caul and other selected fats of the best beeves, using certain intestinal and other lower forms, together with that taken from poorer animals, in making from one to three lower grades. As previously indicated, the manufacture of oleo oil is more widely distributed than that of neutral lard, and, while it is largely confined to the big packing houses, considerable quantities are made in large cities, outside the centers of the packing industry, from fats collected in part from abattoirs and in part from retail butchers. The quantity of oleo oil obtained by the process described is, by weight, about 50 per cent of the fat treated. About 28 per cent is tallow and stearin and the remainder is lost in shrinkage. The quantity obtained from each beef is difficult of exact determination because it varies so greatly with the size and condition of the animal when slaughtered.

Compared with oleo oil, the manufacture of neutral lard is a simple process. Two grades are made—one from the leaf, the other from the back fat of the hog. Its manufacture is almost exclusively confined to large packing houses, but there are independent manufacturers of oleomargarine located near the packing centers who prefer to buy the fat as it is taken from the animal and work it into neutral by their own process. In the packing plants the leaf fat is taken from the animal immediately after killing, hung on mounted racks, and wheeled into refrigerators to remove as quickly as possible all animal heat. It is next chopped fine or reduced to pulp by machinery and melted in jacketed kettles exactly similar to those used for oleo oil. When the melting process is complete it is allowed to settle, the precipitation of the fiber being accelerated by the addition of salt, as in the case of oleo oil. After the settling process the clear oil is siphoned to a receiving tank, and what is not used in oleomargarine is tierced for shipment. A good quality of leaf fat will produce by careful handling about 90 per cent of its weight in neutral, and each animal will yield an average of eight or nine pounds. Comparatively little neutral is made from back fat. The amount used, however, depends much on the relative demand for neutral and ordinary lard products, as it is sometimes more advantageous to work fats into one form than another. The oil made from back fat retains more of the flavor peculiar to lard, and, like the lower grades of oleo oil, is less free from stearin or other undesirable constituents. Some packing houses mix a small per cent of back fat with the "leaf" in making their highest grade of neutral, and oleomargarine manufacturers sometimes use both grades of the finished oil in combination. The difference in price between the two is usually slight, and neutral made exclusively from "leaf" is generally sought. Independent manufacturers of oleomargarine, who make their own neutral lard, give the fat a more extended treatment than that described as the process of the packers. In addition to the separation of the fiber by the process of settling, the clear oil is drawn into a large vat of salt water at a low temperature, where it is again chilled and hardened, and is allowed to remain for several hours. It is then placed on shelves to drain, and is again melted when ready for churning. This treatment carries the neutralizing process to a higher degree of perfection, and improves the texture of the oil.

After a detailed description of the methods of manufacturing its principal ingredients, the manufacture of oleomargarine itself may be described briefly. In those independent plants where both oleo and neutral lard are purchased for use, melting tanks are provided for each, in which they are melted separately, after being taken from the tierces in which they are shipped. They are then piped or pumped to a mixing tank mounted on weighing scales, where the exact proportions demanded by the working formula are ascertained. If cottonseed oil is required by the formula, a separate tank for it is usually provided. If butter is to be used instead of milk or cream, a separate melting tank is also provided for that. After the oils are melted and weighed into the mixing tank together, the mixture is piped or pumped into the churn, where it receives the milk and coloring matter. The whole mass is then churned together, as previously described. In the packing houses liquid oleo oil and neutral lard are piped from the oil room direct to the weighing tank. After churning, the liquid oleomargarine is allowed to flow into a vat of ice water, which chills and hardens it before crystallization can take place. It is next shoveled into mounted cars and wheeled to the "tempering room," where it stands for several hours, until sufficiently softened for the machine butter workers. After the salt has been worked through it, it is put up in marketable form and stored in refrigerators to await shipment. Fig. 2 represents an actual scene in a churning room of a large factory. At the left of the picture is seen a quantity of oleomargarine which has just been taken from the chilling vat after churning, and is ready for the "tempering room." At the right the contents of a churn are being drawn off into the chilling vat. The pipe descending from the ceiling brings a stream of ice water from a reservoir above into immediate contact with the stream of liquid oleomargarine for the purpose of chilling it as quickly as possible. Fig. 3 represents the working and salting process, and Fig. 4 a scene in the preparation of the finished product for market.

While there is substantial uniformity in the process of manufacture, there is great diversity in the grades and combinations of material used and, consequently, in the character of the finished article. The cheapest grades of oleomargarine found on the market are made from the lowest grades of oleo oil and neutral lard, to which is added the limit of cottonseed oil, and the whole is churned with skimmed milk or buttermilk, salted with common salt, and colored with the cheaper grades of coloring matter. These low-grade oils may be manufactured from "scrap" fat and made firm by the addition of more stearin or other similar substances so that a greater proportion of cottonseed oil can be added to the combination. Sometimes glycerin is added to give the product a glossy appearance, and sugar or glucose to sweeten or give texture. The highest grades are made from pure oleo oil and neutral lard of best quality, churned with whole milk, cream, or creamery butter, salted with Ashland salt, and colored with annatto or other coloring matter. The number of grades manufactured varies from two to six, but all large factories receive orders for special lots to be made in a prescribed way. One factory visited by the writer made only two grades—the higher from high-class oils churned with whole milk, the other from low-grade oils churned with the same. In this case the quality of the oleo oil and neutral was the only basis of grading the finished product. In another factory the lowest grade manufactured was a combination of the best oleo oil and neutral churned with whole milk. Three higher or more expensive ones were made with the same oils, each depending for its rank on the amount of pure cream or creamery butter added in the churning process. A large proportion of the independent manufacturers are making a specialty of the higher grades, which include only the best oleo oil and neutral, the grade being determined from the quantity and character of the dairy product added.—Twelfth Census.

LEATHER FOR BOOKBINDING.*

By DR. J. GORDON PARKER.

FOR many years past there has existed a growing dissatisfaction among librarians and owners of libraries with the quality of the leather put on books, owing to the fact that many books bound within comparatively recent years already show serious signs of deterioration and decay. This dissatisfaction grew in volume until a small committee of gentlemen interested in the subject, called together by Mr. Douglas Cockerell under the chairmanship of Mr. Cobden Sanderson, began to investigate some of the causes, and to take evidence on the subject. At this committee a certain amount of information was gleaned, but it was found generally that the exact causes of the decay were not known. Librarians were inclined to lay a good deal of the blame upon the bookbinder, who in turn blamed the leather merchant for the quality of the leather, and the leather merchant when questioned absolved himself of all blame by vaguely talking of new processes of tanning, even hinting as to the existence of some rapid process of transforming skin into leather by aid of acids and other chemicals.

After this, which I may term a preliminary inquiry, the Society of Arts took the matter up, determined that if possible the cause of the dissatisfaction should be investigated. To this end a very strong committee was appointed, under the chairmanship of Lord Cobham, and the members included representative bookbinders, librarians, leather merchants, leather manufacturers, and chemists who made a special study of the leather trade. Of this committee, I formed a humble member, and as a member of both sub-committees which were subsequently formed, as well as of the main committee, I have been asked by several to detail the various investigations which were carried out by the sub-committees, to show samples of the leather which was used and tested, and to give the actual proof and experimental work in detail on which the main committee based its report, which has now been before the public for some months.

I need hardly enlarge upon the work of the first sub-committee, whose object was to justify the cause of the complaint, to find out which leathers appeared to decay most rapidly, and the conditions under which the books were kept, whether the decay was noticed as much in libraries lighted with gas or electric light, whether the bindings appeared to last longer when kept under glass cases, and if possible to note approximately the period at which general decay seemed to set in. This committee in its work visited nine of the most valuable and most important libraries in England, and found generally that most modern leather of all kinds showed signs of decay, and in many cases that bindings of not more than ten years already showed marked signs of deterioration and decay. The bindings of scientific works, proceedings of learned societies, on shelves, bound in calf, of which the date of binding could be very closely ascertained, were in many cases falling to pieces, and in several cases books bearing the dates of 1885, 1886 and 1887 could not be handled without the leather coming off in the form of dust. In another case the removal of the book from the shelf caused the back to come right off.

Generally speaking, as the report clearly states, most sign of decay was found in libraries where gas was used for lighting; and it was also found that, approximately, the most marked form of decay was noticed from 1860 onward. It was certainly noticeable on books bound at any earlier period, but it became more general, comparing all libraries, about 1860.

Through the extreme kindness of several of the librarians and bookbinders I was allowed to detach portions of many of the worst specimens, in order that they might be laid before the second sub-committee for microscopical and chemical examination. This second sub-committee was also supplied with many old bindings and with various samples of bindings, the exact date, nature of the leather, and all particulars being clearly stated.

Turning now to the work of this second or scientific sub-committee, the problems before them were, therefore, of a definite nature. Having first convinced themselves of the almost universal tendency on the part of modern leather to decay, their work was to investigate the cause or causes of this modern decay, and to find out why books which were bound in the fifteenth to the early part of the nineteenth century were still in most cases in almost perfect condition. It was extremely unlikely that any change had taken place in the nature of the raw skins used. It was consequently taken for granted that the causes were to be found in some of the modern processes of leather manufacture. An examination of several pieces of old bindings revealed the fact that the bindings were, generally speaking, thicker than those of more modern date. A microscopical examination showed the fibers of these leathers to be in an upright condition, whereas in more modern leather this is not generally the case; the stretching and tight setting-out of the skin having a tendency to lay the fibers in a more parallel state. Another important factor was revealed by the chemical analysis, which showed that all the old samples of leather analyzed contained less tannin in proportion to the skin substance than was found in more modern bookbinding leather; in other words, it was evidently the custom in the eighteenth and nineteenth centuries to tan the skins in weaker liquors, with the result that the leather was lighter tanned than is the custom at the present time.

Further, and also another important factor was, that in most of the bindings examined which had stood the test of time the tanning material which had been used was in nearly every case either sumach or oak bark, and it was further noticed that in many cases where even fairly modern leather had stood for twenty or twenty-five years the tanning agent had been sumach. Here, therefore, there was indicated a special line of investigation likely to be productive of much useful information. Although sumach and oak bark are still used for the tanning of the better-class high-priced leather, very many skins are tanned with such materials as quebracho (a wood which comes from South America), larch bark, gambier and mimosa bark, and thousands of dozens of sheep, goat and calf skins are sent over ready tanned from India. These latter are tanned with turwar bark, *Cassia auriculata*. These are known in the trade as Persian moroccos, Persian sheep and E. I. calf. Some of these skins are simply scoured, dyed and finished; while the majority are stripped of the loose tannin by scouring in a weak alkaline bath, borax or carbonate of soda being used. As this treatment turns the skins an ugly dark brown color they are put into a bath of weak sulphuric acid. When supposed to be thoroughly freed from sulphuric acid by washing in water, they are retanned with sumach, and afterward dyed and finished in the usual manner.

In order to find out whether any special tanning material had or had not an advantage, and whether the tanning material, *per se*, was liable to cause decay or destruction of the leather, calf, goat and sheep skins were tanned out, one of each skin in each of the following tanning materials: pure sumach, pistacia, lentiscus, tamarix, oak bark, myrobalanus, quebracho, mimosa bark, gambier, larch bark, chestnut extract and oakwood extract. Two sets East India tanned goat, sheep and calf, one set washed, oiled and dried, the other set scoured, soured and sweetened and retanned in sumach as carried out in practice, were also prepared. When these skins were judged to be lightly but thoroughly tanned, one half of each skin was removed from the tan liquor, and the remaining halves were left in the liquors, these being strengthened up with more tannin, so that the second halves were more fully tanned, as is most commonly the case in modern leather. The leathers so produced were rinsed through water to remove superfluous tan, allowed to drip, and when in a semi-dry condition were oiled lightly upon the grain surface, and hung up and dried in the usual manner. Portions of these skins are before you on the table. Pieces of each of these leathers were so fastened upon boards that one half of the piece of leather was exposed, while the other part was carefully covered, so as to be protected from either light, heat or the action of the surrounding atmosphere. In all, eight such duplicate sets were arranged, and were subjected to the following tests for thirty days:

Board No. 1 was exposed to an ordinary direct sunlight. This was done in a large room facing south, and the tests were carried out during July and August.

* Read before the Society of Arts.

The second board was exposed to the action of gas-light. A small cupboard was arranged, and a No. 5 ordinary fish-tail gas-burner was placed in the center of the cupboard, and the boards so arranged round this that the leathers were about 18 inches from the lighted burner.

No. 3 board was arranged in a similar cupboard, and exposed to the light from an ordinary incandescent gas-burner.

No. 4 was also arranged in the same way, but in place of the gas-burner, a 16-candle power incandescent electric lamp was used.

The fifth board was subjected to the fumes of burnt gas. To carry out this experiment a similar room was used 8 feet high and 6 feet square. On the floor of this room was placed an ordinary fish-tail burner, turned about half on, and the boards, with the leather fixed upon them, were hung on the ceiling. A maximum and minimum thermometer was also hung on the ceiling, and the room so ventilated that the temperature was not allowed to exceed 90 degrees F. I may add that this was the temperature noted on the top shelves of two of the libraries which were examined, so in this case the worst library conditions were imitated as closely as possible.

The sixth board was subjected to moist and dry air alternately. This was done by drawing a current of moist and dry air over the leather through a vacuum oven. The temperature was kept at 60-70 degs. F.

The seventh board was subjected to an atmosphere of carbonic acid gas. This test was likewise carried out in an oven, the carbonic acid gas being dried before it was allowed to enter the bath.

The eighth board was subjected to direct sunlight, but the leather was protected from the air by a sheet of glass being laid upon it. This was exposed at the same time, and in the same room as board No. 1.

The leather after this treatment gave some most interesting and instructive results. It showed:

1. That the leathers tanned with certain tanning materials were less affected than those tanned with other materials.

2. That the fumes of burnt gas appeared to act more strongly on all the leathers than any other agent.

3. That artificial light had only a slight effect upon the leather, provided it was protected from the products of combustion.

4. That direct sunlight and air appeared to have a very strong disintegrating action upon most of the samples, but when the leather was protected by a covering of glass the action was less intense.

5. Moist and dry air appeared to have no special deteriorating action. The same thing was noticed in the set exposed to carbonic acid gas. The electric incandescent light appeared to have even less effect than either ordinary gas-light or the incandescent gas burner, probably on account of the less heat evolved and the absence of products of combustion.

On examining all these sets side by side it was noticed that in each case the leathers tanned with sumach were the least affected of any, followed in regular rotation being less affected by myrobalanus, chestnut extract, oakwood extract, oak bark, gambier, larch bark, quebracho, pistacia and tamarix; and the worst set was the leather tanned with turwar bark, especially the sample which had been scoured, soured and retanned. Further, it was also noted that the samples of leather which had been only lightly tanned, were less affected in each case than the samples which had been finished in stronger tanning material, and were thus more heavily tanned. These results showed that the tannins which belong to the pyrogallol class of tanning materials, viz., sumach, myrobalanus, chestnut and oakwood extracts, were the least affected; while, on the other hand, those of the catechol series, represented by gambier, larch bark, quebracho, and turwar bark, became dark red in color and hard in texture. The fibers of the leather appeared to be disintegrated, and in the worst cases the leather could not be rubbed even with a soft cloth without removing a layer of red powder. The tannins of the catechol series appear to part readily with water when exposed to the action of light, heat, or acids, and are converted into red, resinous-like substances which appear to thoroughly disintegrate the fibers of the leather, causing it to become hard and lose all strength.

These above detailed experiments were first carried out at Wrexham by Mr. A. Seymour-Jones, and were afterward repeated by myself in London, and both sets were confirmed by Prof. Proctor in Leeds, so as to leave no doubt about the accuracy of the work. A similar set was treated for sixty days, and some leathers were exposed for three full months. These samples are before you this evening, and can be examined by anyone interested. This was the first stage of the work, and it revealed clearly that tanned goods of which sumach was the tanning material were the least affected of all the tanning materials, and that the East India tanned portions were the most sensitive to either gas fumes, light or heat.

To further test these latter goods, a fresh set of leathers were obtained. An ordinary tanned East India goat and also a sheep skin were purchased in the usual manner, and each skin divided into four parts. A quarter of each was left in its state as purchased; a second quarter was rinsed through water, lightly pressed out, oiled and dried; a third quarter was scoured in alkali, then washed through sulphuric acid, afterward well rinsed in water and then retanned in sumach; and the fourth quarter was simply washed well in water, struck out, and afterward retanned in sumach. These portions of skins were subjected to a similar series of experiments, to the action of gas fumes, direct sunlight, and to diffused daylight for sixty days. Each sample was more or less affected. The quarters which had been stripped with alkali, treated with acid, and afterward sumached showed most deterioration. The portions exposed to the action of burnt gas fumes were absolutely rotten at the end of the time, and could not be handled without breaking or falling into powder. The best sample was that which had been simply washed in water, oiled, and dried, but even this was badly damaged, and turned a deep red color, but it showed that the removal of some of the tannin tended to lengthen the life of the leather; while, on the other hand, the usual trade custom of stripping with an alkali and souring with acid, afterward retanning in sumach, appeared to about halve the already short wearing life of these leathers.

Thus far, then, the committee had discovered the best and the worst leather in its natural tanned state. The next point was, if possible, to find out the cause of the decay in modern oak bark tanned calf. For this purpose several samples of tanned calf skins were purchased and obtained from librarians and bookbinders. None of this leather had been used or exposed in libraries, and most of the samples contained varying quantities of free sulphuric acid, which had evidently been used to brighten the color. Several other samples were therefore obtained free from sulphuric acid. Portions of each of these skins were subjected to the method of testing described, with the result that acid free leather stood the tests in a very satisfactory manner, while the other samples which contained quantities of sulphuric acid, varying from two-tenths to eight-tenths of a per cent, had changed to a red brown color, become hard and brittle, and were easily abraded by friction.

I may say, in passing, that this custom of brightening the color of bark tanned calf with acid, is of comparatively recent date, probably becoming general twenty or thirty years ago. It has a wonderful effect upon the leather; it removes stains or any unevenness in color, generally brightening the somewhat reddish tone, and transforming it into one of a yellower shade, thus giving to the skin a better appearance from the buyer's standpoint. Further tests with bark tanned calf, showed that the heavier it was tanned, the more rapidly it appeared to decay.

The experiments carried out thus far, as will be noticed, were only done with the rough-tanned skins. But it was necessary to find out whether the methods of dyeing and finishing leather in any way impaired its wearing qualities. For this purpose, several kinds of skins, including calf, sheep, goat, seal, and pig, were obtained, and each skin was divided into four portions. The first portion was retained in its rough tanned state; the second portion was struck out, dyed, freed from superfluous dye by rinsing in water, and dried out; the third portion was struck out, dyed, and finished in the usual manner, being glazed after applying an ordinary albumen seasoning, and no acid being added to the dye-bath to develop the color; the fourth portion was struck out, dyed with the addition of an ordinary amount of sulphuric acid, and finished in the usual manner. These series were, as before, exposed to direct sunlight and to the fumes of burnt gas. The results showed at once that the dyeing of the leather where no acid had been used, did not in any way affect the life of the leather. The finishing appeared to protect the surface of the leather somewhat. This would, of course, be expected, as the ordinary finishing process consists of coating the leather over with a thin layer of albumen, and afterward polishing either by hand or machine. This thin layer would naturally protect the tannin from oxidation, and preserve the leather for a certain time. The portions of the skins with which acid had been used in the dye-bath, however, showed signs of decay, and had become hard and brittle. Of the five different skins used, the calf and sheep appeared to be the weakest, while the goat, seal and pig skins appeared the least affected of the five.

In order to ascertain whether the use of sulphuric acid, either as a brightening agent or in the dye-bath, had become universal, from various sources we collected a large number of samples of different kinds of leathers. I have not the details of the number of samples examined by Prof. Proctor, who fully confirms my results, but I personally analyzed 38 different samples of moroccos, and found that 36 contained free sulphuric acid; 18 different samples of skivers were examined, of which 12 contained acid; 32 different samples of calf, out of which 27 contained free sulphuric acid; 18 Persian goat and 23 Persian sheep were also examined, and in all cases free sulphuric acid was found to be present. Six different samples of pig skin were all tested, and in each of the six free acid was found. These were all of English manufacture, some obtained direct from the manufacturers, others from leather merchants and bookbinders.

Knowing that of recent years a large quantity of French and German skins had been used for binding purposes, eight different samples of French Levant moroccos were obtained, and in each of the eight samples a large quantity of free sulphuric acid was found; the lowest contained six-tenths and the highest 1.3 of acid. Twelve samples of German bookbinding leather were in like manner tested, and eleven found to contain acid. The highest percentage found in any was .85 per cent.

It would, perhaps, be unfair to draw a definite conclusion from the few French and German skins examined, but those which passed through our hands were certainly much inferior from the bookbinder's standpoint to any of the English skins. Although the French skins were of a bolder grain and larger in area, they were split down to such an extent that they were little better than paper, added to which a higher percentage of acid was found in this class of goods than in any of the English samples.

It is evident, therefore, that sulphuric acid is of almost universal use, either as a brightening agent or to liberate the dye in the dye-bath.

As it is always customary in tanyards to rinse the skins well through water after souring with acid, it was somewhat surprising to find such a high percentage of free acid still present in the finished leather. Tests were therefore undertaken to ascertain the amount of washing or rinsing necessary to remove the acid. To this end, several pieces of skin were treated with known quantities of sulphuric acid, and then washed for varying periods in running water. It was found to be practically impossible to remove the whole of the acid by rinsing or washing in ordinary water. One piece of "Persian" leather, containing 1 per cent of sulphuric acid, was washed for five days and nights in running water, and at the end of that period it was found that it still contained slightly over two-tenths of a per cent of sulphuric acid, showing that sulphuric acid, as stated in Prof. Proctor's Cantor Lecture, delivered before this Society, appears to dissolve in the leather and adheres most tenaciously to the fibers. It was, however, found that if skins were washed in water containing either potassium or sodium lactate or acetate, the free sulphuric acid was neutralized; where, therefore, it is absolutely necessary to use sulphuric acid the committee recommend that this means of neutralization be adopted.

The committee then turned their attention to the various processes of tanning. Without wearying you with all the details of the experiments made, I will merely state that it was found in general that skins which had come from abroad preserved in salt were when tanned weaker in texture than either dried or fresh skins. Skins which were in any way tainted, or even only slightly decomposed, were extremely weak.

Many sheep skins arrived in this country from New Zealand and Australia in what is known as the pickled condition. These skins are pickled in a solution of salt and sulphuric acid. Several of these skins were tanned and compared against unpickled skins, and it was found that the leather produced from skins which had been pickled was much inferior in strength and durability to the unpickled.

Low liming and the use of the stale limes containing quantities of free ammonia, were found to weaken the pelt, as also over-puering, a process which is used to rid the skin of lime, and, at the same time, to pull down its thickness, and to make it soft and pliable.

Many of the finished leathers examined microscopically by us showed that the skins had been distinctly over-puered. This was very noticeable in a series of pig-skin bindings of one of the large public libraries.

Another interesting feature, already referred to, was that leather appeared to lose in strength and durability the more heavily it was tanned, and this point is one which leather manufacturers should watch. I am of opinion, as expressed in the report, that the skins for bookbinding purposes should be lightly but thoroughly tanned; not what would be termed "dead tanned." They should then be rinsed lightly through water, should not be tightly set out, and should not be dried in a stretched condition. It is the custom to dry many kinds of leather strained tightly over boards. This tends to lay the fibers in a flatter and more parallel condition, and to keep the fibers all taut, removing from the skin its elasticity and also what I may term the cushion effect which is produced when the fibers run transversely to the skin.

Many of the different samples examined, both on and off books, were found to be shaved down or split so that only the thin grain surface remained. It required no investigation to prove that this was contrary to all reason, and that shaving the skin down to the thin substance could not but reduce the leather to about the level of brown paper as a binding agent.

Mr. Douglas Cockerell was good enough to obtain for me from different sources sets of samples of six different substitutes for leather for bookbinding purposes. It would be better for me on this occasion not to mention the names of these substitutes, although they are all well known to bookbinders. These mostly consisted of cloth or cotton foundations, covered over with some material of a waterproof nature, which by skilful processes could be made to imitate almost any class of skin. These samples were each subjected to a series of tests similar to those that the leathers had undergone, and although sunlight or artificial light appeared to have little or no effect upon these substitutes, they were more easily affected by the fumes of burnt gas than even the poorest qualities of leather. Moreover, in dry atmosphere they become hard and somewhat brittle.

Examination was next made of some of the methods used by bookbinders for brightening the leather and for sprinkling, and also of the pastes which were employed by them in their workshops. To this end the committee were willingly supplied by various binders with samples of sprinkled leathers and treed calf, also samples of leather which had been washed with oxalic acid to brighten the color. It was found that sprinkled leather soon went into holes, and leather which had been washed with oxalic acid also rapidly darkened in color, and became very hard and brittle when exposed to the sun's rays.

The pastes on the whole were found to be harmless, but from the leather standpoint we cannot too strongly emphasize the damage which must be caused to the leather by stretching it out too tightly over the back of the book in binding.

Before concluding this somewhat lengthy account of the different series of experiments carried out, I would point out one fact which at first was somewhat puzzling. We found that sumach-tanned leathers in every case stood all the tests better than any other, but that some samples of sumach-tanned leathers deteriorated, while others showed no sign after even sixty days of sunlight. On examining carefully the leathers referred to it was found that some of the rough-tanned sumach skivers contained free sulphuric acid. As the source of supply in two cases was known, the firms in question were written to, and it was acknowledged that a small quantity of sulphuric acid had been put in the sumach tanning vats to give the skins a slightly thicker feel.

But another cause for the differences in sumach-tanned leather is the fact that cheap brands of sumach are invariably adulterated with the leaves of two other materials, viz., pistacia and tamarix, and it was the presence of these adulterants which caused some of the sumach-tanned leathers to show deterioration. This discovery led us to tan out skins with tamarix and pistacia, in order to see how they behaved in comparison with sumach tannage, and as the first series of experiments showed, they were considerably worse than even larch or gambier-tanned skins.

It was our duty to give if possible some advice to librarians and others as to the preservation of books bound in leather, and Prof. Proctor undertook an elaborate series of experiments with glasses of various tints in order to find out whether the disintegrating effect of sunlight could be minimized by the use of lightly tinted glasses. His experiments were eminently satisfactory. He found that the violet or actinic rays which affected photographic printing paper also affected the leather, so that any glass which would keep out the actinic rays could be recommended for the glazing of library windows.

I have endeavored to state as clearly as possible the details of the chief experiments which were carried out by us, in order that the leather trade may be able to judge whether the grounds on which the report is

based are sufficiently strong. Many other experiments were done, but I will not lengthen this paper by detailing them, as they were of lesser importance than the ones I have given. I need only say that every statement and recommendation made in the report, the grounds for those statements, and the experimental and practical work on which they are based, were confirmed by each individual member of the sub-committee, so that their conclusions cannot, as has been stated by some critics, be considered as being simply the "opinions or fads of professional men."

Before bringing this paper to a conclusion, I should like to refer to a fact that impressed us very forcibly, viz., the number of disguises under which the ordinary sheep skin masqueraded. We found books bound, nominally, in levant morocco, hard grain morocco, straight grain morocco, pig skin, calf skin, crocodile, and alligator leathers; which leathers on close microscopic examination, were found to be the ordinary common sheep skin, on which had been stamped, probably by electrotype rollers, the special grains and markings of the skins they were got up to imitate. In many cases both the bookbinders and the librarians had bought these leathers under the impression that they were buying the genuine article, the buyers having probably been tempted by the low price which would naturally be charged in a case of this sort.

The question of price brings us, I think, to one of the most important points in connection with this investigation. I may be wrong, and it may be that I am not sufficiently connected with the commercial side of the leather trade to form a definite opinion, but I venture to give my views on the subject for what they are worth. I believe that a good deal of the leather of the cheaper sort which has been found to decay is largely the fault of its cheapness. The librarian has stipulated that his books must be bound at a certain contract price. The bookbinder has, in consequence, to procure a cheap class of leather. This he has in most cases easily found, as there is always a large quantity of cheap leather on the market, splendidly finished, and to all appearances of first-class quality, which owes its high finish and good appearance to the use of materials in manufacture which are injurious to its strength. I think it is therefore clearly the duty of the librarians, if they are determined to have a leather which will last, to put in their specifications, when high-class work is required, that the leather must be of pure sumach tannage; secondly, that no mineral acids must have been used in any process connected with the manufacture of the leather; and thirdly—also an important point—that the skins used must not have been pared down or split to paper thickness. For small books, small and thinner skins must be used in the binding.

Sumach-tanned calf can be obtained and can be dyed to the brown shade so much liked in the case of ordinary brown calf; bark-tanned calf can also be used in binding, provided the leather is not over-tanned, and has not been brightened by the use of acid; but I think there is not the slightest doubt the librarians must in future, if they wish a leather to last more than from ten to fifteen years, insist on their specifications being carried out to the letter, and they must be prepared to pay a correspondingly higher price for a guaranteed article. Low quotations in most cases are to be regarded with suspicion. Chemists have now obtained sufficient knowledge to be able to test leather both chemically and microscopically (1) for the presence or otherwise of acids; (2) to ascertain if the leather is over-tanned; (3) the tanning material used, and (4) to ascertain whether the fibers are in a good healthy condition, or whether the skin has been damaged either in the early liming or puering, or in the later finishing processes.

I believe that in many cases the manufacturers themselves are not wholly responsible for their leather being spoilt. The buyers often demand high finishes, bold grains, and other characteristics in the leather, such as can only be obtained at the expense of its strength and durability. In many works the finishers use both alkalies and acids at different stages to produce certain results, and in nine cases out of ten they do not understand the action of the materials, and do not know that their use damages the leather. It seems to me that it would not have been necessary for this committee to sit, and for its members to spend so much time and trouble on this investigation, had the workmen, or, more important still, the leather manufacturers themselves, possessed greater knowledge of the principles underlying leather manufacture.

The work of the committee is not yet completed, as the question of the fastness of different dyes is still under investigation. The committee hope that this part of their work will be finished by next summer.

WATER TUBE BOILERS.—II.

By the ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

THE YARROW BOILER.

ANOTHER very satisfactory and serviceable type of water tube boiler, especially for torpedo boats and similar other small craft, is the Yarrow. It first came into significance on account of its remarkable durability and efficiency upon the torpedo boats for the Dutch government, which were constructed by Messrs. Yarrow & Co. at their Thames shipyard at Poplar. The attention of the British Admiralty was attracted by its success upon the vessels; and it was thereupon introduced into the British navy. But although it has been principally utilized for small warships, it has recently been installed with success upon the largest and heaviest vessels.

The first practical Yarrow boiler was constructed in 1889, and was the outcome of numerous experiments and investigations since 1877. It belongs to the "drowned" class of boilers, the steam being delivered into the upper drum below the water line. The inventor, as the result of his researches, was of opinion that this system of steam delivery into the drum was more successful than the foaming class of boiler, as circulation is more efficient and complete.

In general appearance it is not unlike the Thornycroft boiler. In form it resembles an inverted V with the fireboxes at each of the two lower corners of the triangle. But its most important divergence from the Thornycroft pattern, in addition to the delivery of the steam in the upper drum being below, and not above, the water line, is that the tubes are straight. The question of whether straight or curved tubes are the most efficient has been one round which has raged spirited discussion among engineers; and when the pros and cons of the advocates of the two principles have been analyzed, the superiority of either type practically resolves itself into a question of individual taste. The curved tubes, as adopted in the Thornycroft boiler, have been conspicuously successful, and equally so have been the straight tubes of the Yarrow. In view of the fact, however, that the straight tube principle is utilized in the large majority of water tube boilers and offers special facility for cleaning, all things being equal it certainly has this preponderating advantage.

The two very conspicuous advantages of the straight tube boiler are the facility and expedition with which the tubes can be cleaned, and the ease with which a defective tube can be removed and replaced. The straight tube principle dispenses with the necessity of keeping a variety of tubes in stock, since the tubes are all of the same dimensions. In the early days of the water tube boiler, it was maintained that in the case of the straight tube boiler, owing to the fluctuating temperatures and the consequent unequal expansion and contraction of the tubes, a great strain was thrown upon the rigid portions of the boiler. No doubt this was an inherent defect of the earliest straight tube boilers, but it has now been efficaciously eliminated. In the Yarrow boiler there is a great elasticity of structure.

The accompanying design will comprehensively illustrate the principle of the Yarrow boiler. The upper or feed drum extends the full length from back to front. The tubes are expanded directly into this drum in two groups, one on each side. The lower ends of the tubes are similarly expanded into the smaller lower drum at each corner. The lower drums it will be noticed are not circular, but semicircular, with the flat side uppermost to receive the tubes just below the fire level. The fire is between the two lower drums.

Circulation is accomplished in an ingenious manner, which insures the boiler being compact and economical. There are no down pipes to carry the water from the upper to the lower drums. In the earliest types of Yarrow boiler they were included, but the inventor in the course of some experiments discovered that they could be dispensed with altogether, and instead the water be carried from the feed water drum to those below, by the tubes nearest the outer casing of the boiler, which are played upon by the coldest gases of the furnace.

The question as to whether more efficient circulation can be obtained with boilers equipped with the external downcomers, than with steam generating tubes themselves, has been one of animated controversy among engineers. Mr. Yarrow himself is a firm advocate of the utilization of the steam generating tubes being used for this purpose. In order to support this theory, he carried out a series of experiments with an apparatus specially devised for the purpose before a number of the leading marine engineers in Great Britain, and we are enabled to reproduce herewith a number of photographs in which he clearly demonstrated his theory.

The initial experiments were carried out with the apparatus represented in one of our illustrations. It consists of two parallel glass tubes placed vertically. The lower ends of these tubes were joined together by a copper bend, while the other ends terminated in a drum. Three Bunsen burners were arranged beside each tube, and so arranged that they could be brought to bear upon any part of the tube as desired. An indicator was placed above the drum. This consisted of a rocking arm pivoted in the center, with a light rod at each end, the upper extremities of which met this, forming, together with a rocking arm, a triangle, the apex of which served as a pointer upon a graduated scale placed behind it. A light cord with a small elongated bob attached to one end was placed in one of the tubes and the other end was suspended from one end of the rocking arm. This bob was grooved on its external surface. By means of this bob a comparative record was obtained of the rapidity of the flow of water, or water and steam in the pipes.

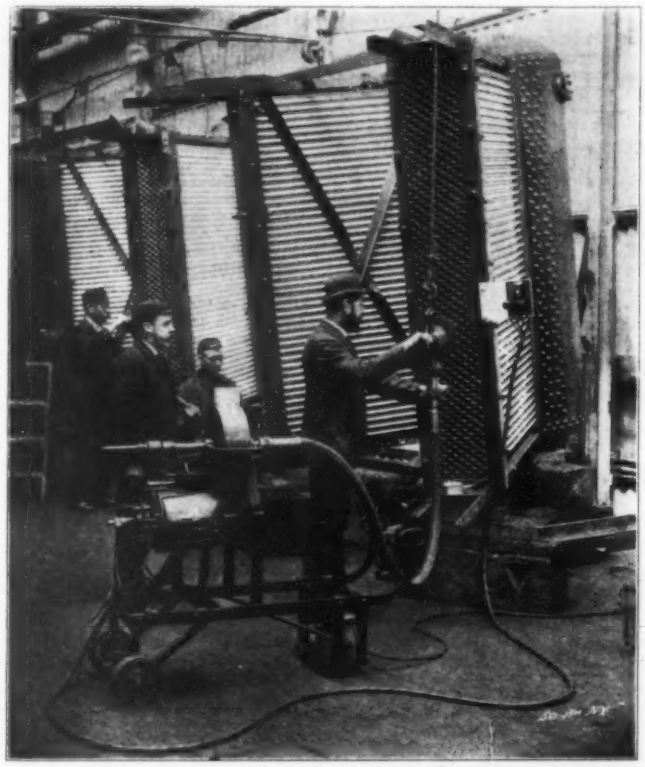
When everything was cold the indicator was deflected in the manner shown in the first illustration, the pointer standing at 45 or zero. One burner was then ignited and played upon the up tube, but the current thus set up was too intermittent in character to enable any useful data to be obtained. A second burner was then applied, and the bob was pulled down by the circulation until the pointer stood at 12; when the third lamp was brought into contact with the tube, the rocking arm was still more deflected until the indicator stood at 5—the maximum recorded by the current when heat was applied to the up tube only.

One of the Bunsen burners on the down tube was then brought into action and the pointer immediately traveled farther along the scale and stopped at the point 10; moved to point 15 when the second lamp was lit; and when the third lamp was brought into contact with the down tube, it reached its maximum point 20. At this juncture all six lamps were burning, three playing on the up and down tubes respectively. It must be clearly understood that the scope of this experiment was not to demonstrate the absolute rapidity of flow in feet per minute, but was simply a comparative test, and the object lesson clearly showed that application of heat to the down tube considerably increases circulation.

In another test, however, in order to substantiate conclusively Mr. Yarrow's contentions on this vital point, the apparatus was devised and equipped with a special recorder to illustrate the absolute rapidity of the flow. In the down tube, a screw of which the pitch was known, was suspended by a spindle at the upper end, and above the receiver drum was a worm which actuated a wormwheel connected to the pointer or counter to ascertain the speed of the current. When two Bunsen burners were playing upon the up tube the propeller registered a speed of 28 feet per minute, and by the addition of the third burner, the velocity was increased by 8 feet to 36 feet per minute. When one lamp was brought to bear upon the down tube the velocity was further augmented to 42 feet; 49 feet per minute with three lamps burning upon the up tube and two on the down tube; and a maximum of 55 feet when three burners were playing on each tube. It will thus be observed that the application of a degree of heat to the down tubes equivalent to that applied to the up tubes resulted in an increased flow of 19 feet per minute—approximately 50 per cent.

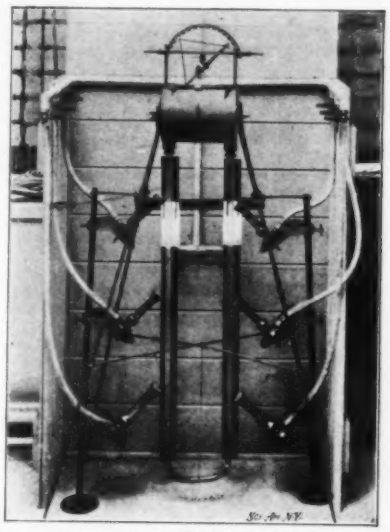
The third demonstration with the apparatus was of special interest relative to the arrangement of the tubes at a slight upward angle from the horizontal. The tubes leading to the receiving drum were in this instance bent sideways, thus reducing the vertical extension. In this experiment the heat brought to bear upon the tubes was not the same, as smaller burners were brought into contact with the down tube than those on the up tube, but nevertheless an appreciable increase in the rapidity of flow was obtained. There was one very important feature prominently apparent in the course of this experiment. The bubbles of steam generated in the down tube disappeared, a peculiarity considered due to the greater pressure in the lower part of the pipe.

In a fourth experiment another test in the same direction was made, though the arrangement of the tubes was somewhat different, approximating as far as possible to the general arrangement of the tubes



EXPANDING THE ENDS OF TUBES INTO DRUMS WITH ELECTRICAL EXPANDER.

in an actual Yarrow boiler. Three tubes were placed side by side, composed of glass with copper ends joined together. The lower ends terminated in an asbestos-lined metal casing, while the upper extremities led into a drum. The Bunsen burners in this instance were placed at one side of the case, so that the flame was brought to bear upon the outer tube, and the heated gases passed the other two tubes on their way to the small chimney shown. When the burners were ignited they started an upward current in the tube nearest the flame, while the other two tubes acted as downcomers. In a few minutes, as the heat was increased, the tube next to the one in which the up current was started ceased to act as a downcomer,

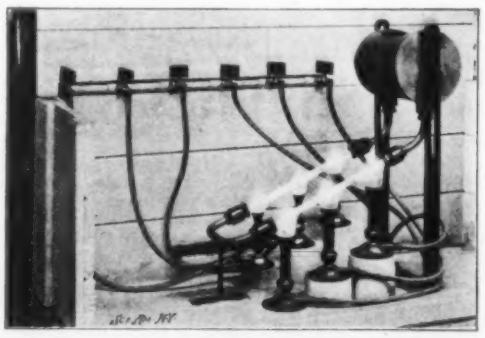


APPARATUS FOR TESTING THE CIRCULATION OF WATER IN YARROW BOILERS BY UTILIZING OUTER TUBES AS DOWNCOMERS FROM THE FEED TO LOWER DRUMS.

but carried an ascending current, leaving only one downcomer, but the third tube proved sufficient to bring down all the water required for efficient circulation. Nine pounds of water per square foot of heating surface has been evaporated with this model apparatus.

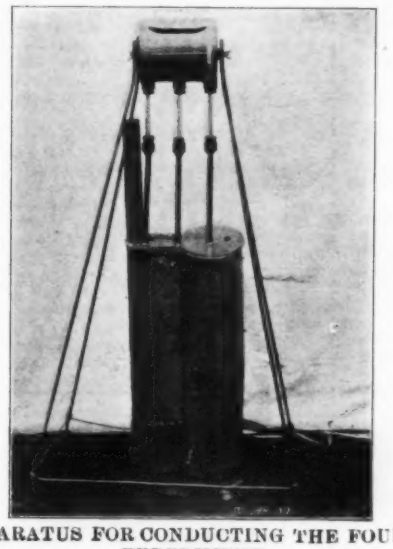
It must be remembered that all the foregoing experiments were carried out at atmospheric pressure, but now Mr. Yarrow demonstrated his thesis in a much more forcible manner. For this fifth experiment the apparatus was fitted with a closed drum or steam chest having a steam gage instead of an open receiver. Glass tubes with copper connections at the bottom were employed as before. In this experiment a high steam pressure was obtained. Three small burners started the circulation, supplemented a little later by five large burners clustered round the downcoming tube. By this means the rapidity of circulation was greatly increased, and was maintained in the same direction, the tube which was so much more highly heated remaining the downcomer. Steam rose until a pressure of 150 pounds was registered on the gage. The three small lamps applied to the tube were then gradually extinguished, but the current of steam and water was still maintained in the same direction, although the whole of the heat applied was received through the downcomer pipe.

The general method of manufacturing these boilers is as follows: The tube holes in the top steam and lower drums are bored through a template; the drums are then completely riveted up, and three are then mounted in position upon a triangular frame. The tubes are then placed in position with a number of gaps on the fire side, so as to bring a great number of tubes into contact with the fire, and which also relieves the outer tubes, which are severely worked. By this arrangement the combustion space is appreciably increased. The ends of the tubes projecting through the orifices in the drums are then expanded and bell-mouthed. This process does not weaken the strength of the tubes at this point, as some engineers maintain, but it most efficaciously surmounts a common trouble in some water tube boilers—leakage. The tube ends are easily accessible, since there are manholes fitted in the steam and water drums opening inward, and fitted with internal doors. The method of bell-mouthing the ends of the tubes inside the drums considerably improves the flow of the water into the tubes, so that



APPARATUS FOR CONDUCTING THE THIRD EXPERIMENT.

A certain number of tubes at each end of the water pockets may be baffled off from the fire in order to act as permanent downcomers, and also to maintain as far as at all practical a uniform direction of circulation in the boilers. In the water tube boilers of the Yarrow type installed on the battleship "Don Carlos" for the Portuguese navy, no stay tubes were distributed throughout the tube plate, as they are open to certain objections which militate against the efficiency of the boiler, the most noticeable of which is their greater thickness, and consequent different degree of expansion to the actual water tubes. They are not at all necessary, since the boiler tubes are sufficiently strong to fulfill the requirements of stay tubes. In the case of the



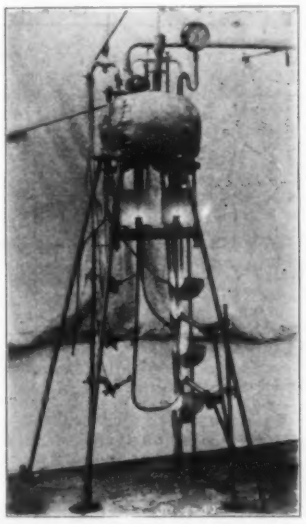
APPARATUS FOR CONDUCTING THE FOURTH EXPERIMENT.

tubes for the "Don Carlos," in the experimental strain tests a tube 1¼ inches in diameter, 0.104 inch thick, projecting ¼ inch above tube plate, and simply expanded therein, required a load of 4.6 tons being drawn out, and a similar tube 1 1-6 inch above the tube plate resisted 4.22 tons; and a third tube, the end of which was just flush with the plate, resisted a 33-ton load.

In the "Don Carlos," which was the first large battleship fitted with the small water tube as represented by the Yarrow type, and was therefore somewhat of an experiment, there were twelve boilers arranged in two water-tight compartments, for the Yarrow type is essentially and primarily a small-vessel boiler—not that we mean to say that it is only adaptable to small craft, but in such vessels it has proved an unqualified success.

One very prominent feature of this boiler, and which is a strong recommendation for its utilization, is the ready accessibility to the component parts. The form of casing generally adopted is an arrangement of panels which can be quickly and easily removed.

The Yarrow boiler is extremely economical. Weight for weight, it will develop as much as 50 per cent more power for long periods, and 65 per cent more power for short periods than the ordinary cylindrical boiler. Its evaporating capacity also is very high. An interesting experiment was carried out recently in this direc-



EXPERIMENTAL APPARATUS USED BY YARROW.

tion with a boiler for a cruiser, the heating surface of which boiler was 3,000 feet, and the drop in economy and the drop in the steam-generating power at the time of cleaning the fires, etc., was very marked. The evaporation at the end of the 30 hours' trial to which the boiler was subjected was 11 pounds of steam from and at 212 deg. Fahr. per pound of coal; and during the 30 hours the evaporation was 10½ pounds of steam per pound of coal, the consumption being at the rate of about 30 pounds of coal per foot of grate.

The Yarrow boiler is essentially of the small tube type, and if the results in the past experienced by the various powers afford any criterion, the small tube boiler is indubitably most efficient even when installed in vessels of 10,000 tons and upward. The Dutch navy has exclusively adopted the Yarrow small tube boiler, and the greatest satisfaction has been obtained. In the case of large warships on long voyages, the large tube boiler is actually not so economical as the cylindrical boiler, so that with the exception of being able to raise steam to the maximum pressure in a few minutes, no real, definite advantage from the adoption of the water tube boiler is found except in reduction of weight.

With the Yarrow boiler, however, quite a distinctly different result is obtained. The tubes are a trifle larger than those employed for small craft such as destroyers, and the thickness of the metal is somewhat increased. Such alteration naturally means a certain sacrifice of lightness, and possibly to a certain extent an increase in the amount of space required by the boiler, but these slight increments are adequately compensated by the fact that the tubes are rendered more durable, and there is a greater economy of fuel. In the case of the Yarrow boilers adopted for large warships, the diameters of the tubes are increased from 1 inch or 1¼ to 1¾ inches. With this type of boiler as compared with the shell boiler the difference is very marked. Practical experience has proved that a Yarrow boiler developing 1,000 horse power occupies exactly the same space as a cylindrical boiler developing only 930 horse power, and a difference of 70 horse power per 1,000 means a considerable saving in boiler space in large vessels where 14,000 horse power is to be obtained. More striking still is the actual saving in weight of the boilers. A Yarrow boiler developing 1,000 horse power is 25 tons lighter than a cylindrical boiler developing 930 horse power.

There is one very important point which the makers of the boiler impress upon any power that decides to introduce it into its navy. That is, uniform size of tube throughout the fleet. The great advantage of this standardization is that the naval authorities of a certain power do not have to stock a number of tubes of varying diameters, since the tubes are common to any vessel in that particular navy.

The Yarrow boiler, on account of its great efficacy, economy both in fuel consumption and space, its immunity from breakdown, the facility and celerity with which defective tubes can be removed, and the ease with which the tubes can be cleaned, is being widely adopted for war vessels both small and large. The Swedish naval authorities are installing it upon their recent vessels, and the Austrian government, which is now laying down three armored cruisers of 11,000 tons displacement and 14,000 indicated horse power, have decided in favor of the same boiler.

UTILIZATION OF EXHAUST STEAM.

A REMARKABLE instance of successful reclamation of waste energy is described in a recent issue of L'Industrie Electrique. At the mines of Bruay, on the straits of Dover, the exhaust steam from the hauling engines had heretofore been allowed to escape to the atmosphere, the intermittent operation of the engines, and the difficulty of applying a sufficient expansion, rendering condensation impracticable. However, a Rateau steam turbine has been put down, which is driven by the steam from the low pressure cylinder of the main engine, and is coupled to two dynamos of 100 kilowatts each. The turbine runs at a speed of 1,600 revolutions per minute; it consists of seven disks, 90 centimeters in diameter, fitted with vanes, the outer case being 110 centimeters in diameter and 120 centimeters long. The dynamos run at the same speed as the turbine, and generate current at a pressure of 240 volts.

The steam pressure on admission to the turbine is below that of the atmosphere; in trials made, it was found to be about 13 pounds per square inch absolute. The turbine exhausts into a condenser at a pressure of 3 pounds per square inch. Under these conditions, an output of 310 estimated horse power was obtained, with a consumption of 40 pounds of steam per estimated horse power hour, a much better result than had been anticipated.

In order to overcome the irregularity of the steam supply, due to the intermittent working of the main engines, a novel form of thermal storage was devised by M. Rateau. The apparatus consisted simply of an old boiler filled with several tons of scrap iron. In passing through this the steam gives up heat, falling for example from 105 degrees C. to 98 degrees C.; but when the main engines stop, the process is reversed, the condensed steam being re-evaporated. Provided that the stoppages of the main engines are not too protracted, a practically uniform supply of steam for the turbine is obtained by this means. When necessary, however, steam can be supplied to the turbine from the boilers, through a reducing valve.

It is interesting to speculate whether it would be possible to make use of the system more generally. It is well known that it is not economical to expend steam below a certain pressure—approximately that which is necessary to overcome the friction of the engine. In the turbine, however, expansion can be carried to a much higher degree without disadvantage.

It is stated that trials made by M. Picou with the plant above mentioned, fully confirm this view. Although it would probably be impracticable to apply the system in any but a few instances, it is still worthy of note, especially having regard to the remarkably large output obtained.

Unfortunately, particulars of the size of the main engines and of the actual total cost of the energy reclaimed, are wanting.

PAINTING STRUCTURAL IRON.

JOHN MURPHY, of Montreal, writes to the Painters' Magazine as follows: The most effective method that I think of at present for the prevention of rust would be: After having cleaned the metal thoroughly from all loose dirt, scaling or grease, in the factory, to give a liberal coating of boiled oil, applied hot. This would find its way into all the crevices, cracks or holes in the iron, where paint could not enter on account of its thickness and incapability of running, not only in cracks and holes, but on perfect surfaces, where little lumps or roughnesses are found. If the painting is done

carelessly the brush slips over these places and leaves around every little protuberance a mass, be it ever so small, perhaps imperceptible to ordinary eyesight, but sufficient to furnish a growing place for rust. I have never seen the process I recommend specified by any of our architects. I am sure that it would be a great improvement on the present method of painting iron, and it would furnish a fine preparation for future painting or covering with cement coating, such as has been suggested. To make "assurance double sure," I should recommend two coats of the hot oil instead of one.

THE NAVAL WAR GAME.—III.

By FRED T. JANE.*

AN INDECISIVE ACTION IN THE FAR EAST—CAPTURE OF THE "KAISERIN AUGUSTA."

As already stated, the assumed *casus belli* is German action in the Far East. For the purposes of the game, the Germans were assumed to contemplate designs on one of the outlying islands of the Philippine group. In connection with this the fleets maintained by both the United States and Germany in the Far East concentrated, the Germans being first at this off Cape Bojeador. Here, shortly after dawn, they were found by the American fleet, which steamed toward them. The Germans signaled to the Americans to keep away; this being disregarded, they opened fire. When the fleets sighted one another they were about 11,000 yards apart, and both were in two divisions line ahead. The Germans were led by the "Bismarck" (flag), followed by the "Hertha," "Hansa" and "Kaiserin Augusta," steering north. The "Gazelle" and destroyer "Taku" were in a second division to port—the American fleet being off the starboard bow of the "Bismarck." The American starboard division, which was some six cables ahead, was formed of the "Brooklyn," "New York" and "New Orleans." The port division consisted of the "Kentucky" (flag), the monitors "Monterey" and "Monadnock," and the cruiser "Newark," all ships being in the order named.

Altering course eight points to starboard, the American ships were bows on to the German when these opened a heavy fire on the "Kentucky" and "Brooklyn" at 8,000 yards. These were the only American ships able to reply immediately. Very poor shooting was made at so great a range, but almost the only effective hit struck the "Kentucky's" conning tower, "killing" the admiral who had elected to be there, and rendering the ship temporarily unmanageable. This, coupled with the fact that their speed advantage enabled the Germans to keep ahead, told against the American fleet. The "Brooklyn's" division, to avoid dropping out of range, was compelled to keep bow on—a position in which it was only able to deliver a limited fire; and had the Germans swung round to starboard, it is possible that the American cruisers would have been masked by the heavy division. The Germans, however, did not attempt this, either fearing to get too near the armorclads, or else preferring the alternative that they presently took.

Bearing away to port, so as not to allow the "Kentucky" to close, the Germans suddenly altered course sixteen points, returning south at top speed. The object of this maneuver was to get the "Brooklyn" division between them and the battleships, but the attempt was frustrated by the Americans. Still, the "Newark" was at this stage rarely able to fire, and the monitors only managed to do so occasionally. The "Brooklyn" suffered badly and the "New York" was heavily damaged, dropping astern. There seemed every prospect of the cruisers being overwhelmed before the slow division could come near enough to help them materially.

Recognizing this, the senior American officer ordered the cruisers to return. In doing so, they masked his battleships for two or three minutes, but the move saved the day. The Germans also altered course, no doubt expecting the battleships to do the same. Instead, these kept straight on, and so soon as the cruisers cleared them, got their broadsides into the Germans at 4,000 yards, wrecking the "Kaiserin Augusta" and badly damaging the already severely handled "Bismarck."

With this the Germans suddenly discovered that they had had enough; and, bearing away in line abreast, they left the disabled "Kaiserin Augusta" to her fate. To stand by would have meant fighting the slow squadron, and this they were totally unable to risk. So they went off while they could, and this ended the action; for the Americans had not a sufficiency of fast ships to follow. But for this the "Gazelle" would probably have been captured also, for she was badly knocked about.

Nothing more being possible either side, the Americans having watched their opponents well toward Kiaochow, returned to Manila to refit.

DAMAGES SUSTAINED.

A detailed list of damages in this indecisive action is as follows:

American Fleet.

"Kentucky." (Four 13-inch, four 8-inch, fourteen 5-inch.) Conning tower hit. Both superposed turrets jammed or otherwise disabled.

"Monterey." (Two 12-inch, two 10-inch.) Not hit.

"Monadnock." (Four 10-inch.) Not hit.

"Brooklyn." (Eight 8-inch, twelve 5-inch.) Entire forward part wrecked, all save after turret out of action, crews cleared from all save the four after 5-inch guns. Fore funnel gone. Two hits on waterline.

"New York." (Six 8-inch, twelve 4-inch.) Only the starboard 8-inch left. Out of action and probably not worth repair.

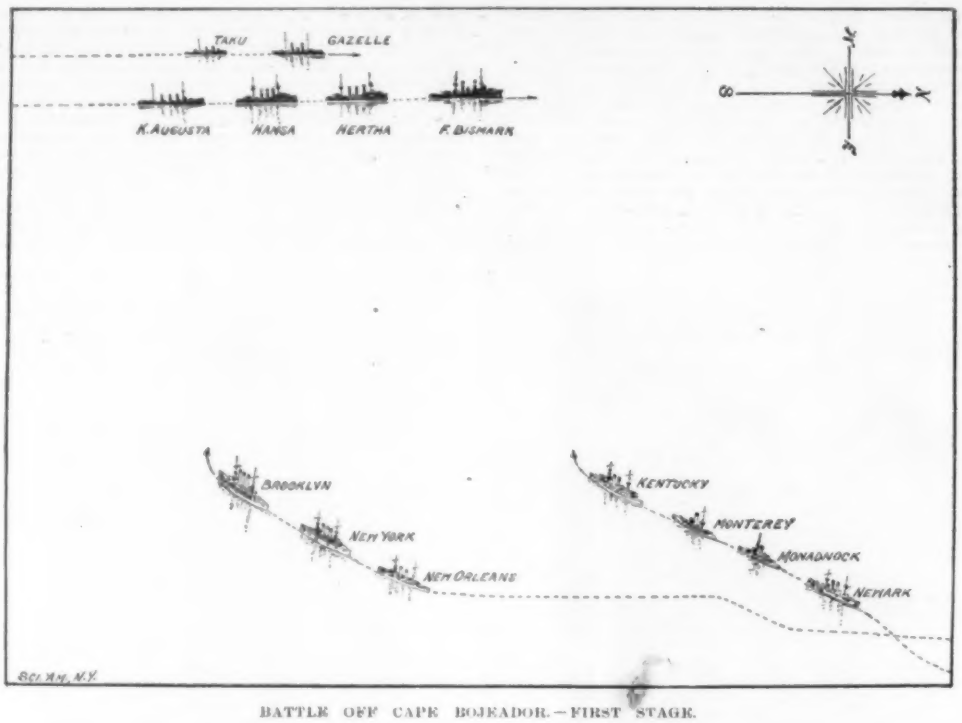
"New Orleans." (Six 6-inch, four 4.7-inch.) All four amidship 4.7-inch cleared out.

"Newark." (Twelve 6-inch.) No serious damage.

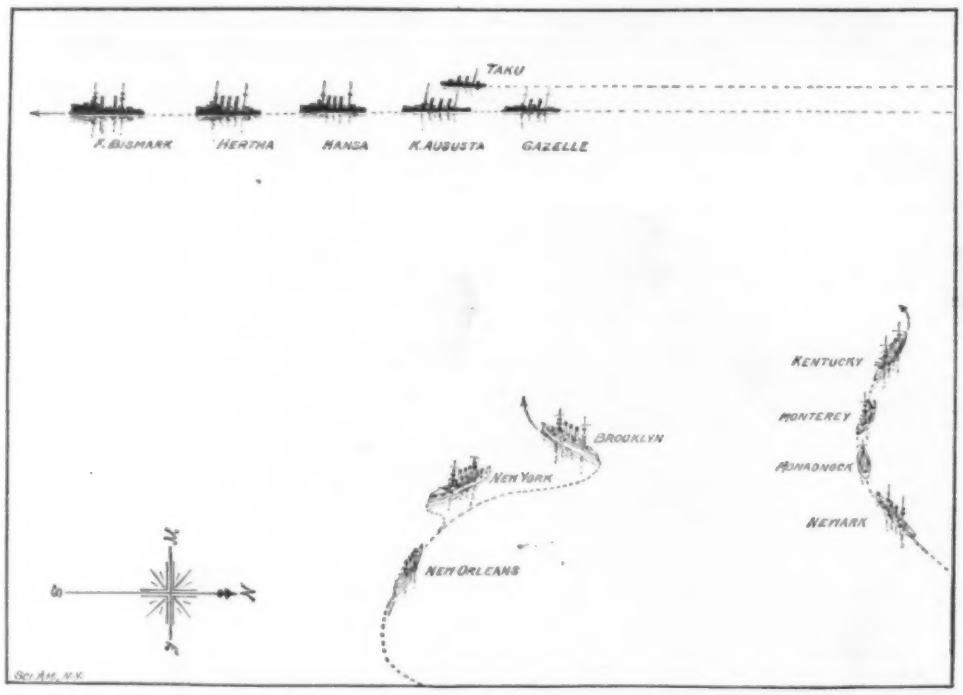
German Fleet.

"Bismarck." (Four 9.4-inch, twelve 6-inch, ten 3.4-

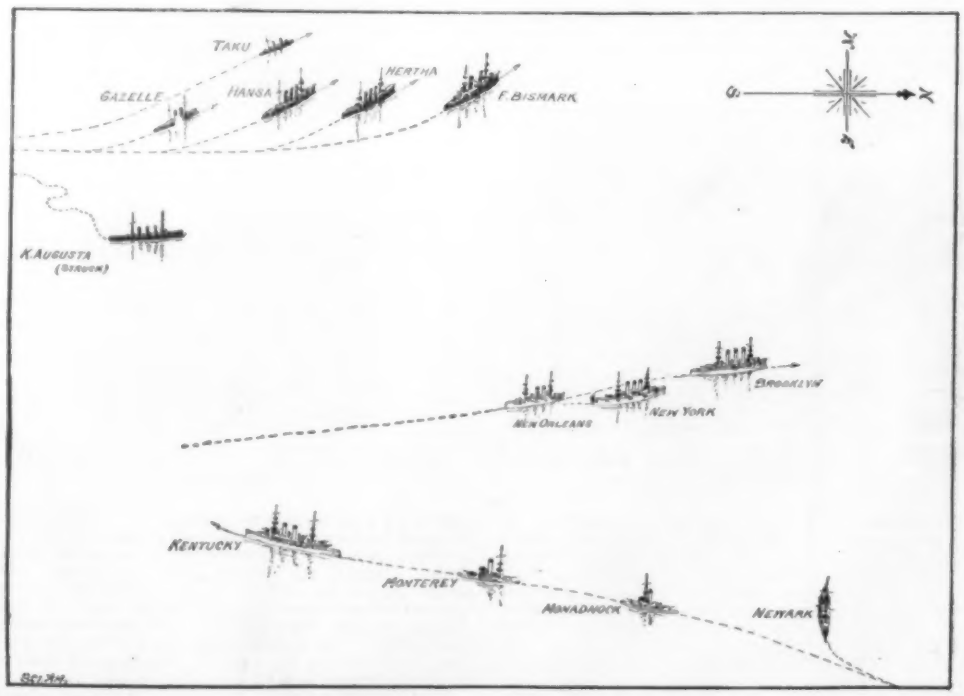
* Prepared especially for the SCIENTIFIC AMERICAN by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the SCIENTIFIC AMERICAN SUPPLEMENT of December 20, 1902.



BATTLE OFF CAPE BOJEADOR.—FIRST STAGE.



BATTLE OFF CAPE BOJEADOR.—SECOND STAGE.



BATTLE OFF CAPE BOJEADOR.—THIRD STAGE.

THE NAVAL WAR GAME.—III.

inch.) Both turrets out of action, forward group of 6-inch gone, after 6-inch gone. Bad hit on the waterline. Speed much reduced. Both masts gone.

"Hertha." (Two 8-inch, eight 6-inch, ten 3.4-inch.) Forward 8-inch, two 6-inch disabled. Badly hit on waterline.

"Hansa." (Two 8-inch, eight 6-inch, ten 3.4-inch.) No serious damage.

"Kaiserin Augusta." (Twelve 6-inch, eight 3.4-inch.) All guns disabled. Bad hit in waterline. Engines disabled. Waterlogged. Struck to the U. S. fleet.

"Gazelle." (Ten 4-inch.) Hit on waterline. Speed much reduced. Nearly all guns disabled. Conning tower blown away. Funnels both gone.

"Taku." (Destroyer.) Not touched.

The plan of the action in its chief stages will serve to explain all that is not otherwise stated here; though it should be added that the Americans were not aware of how considerably damaged the German fleet was.

A summary of the opposing guns is as follows:

Inches 13	12	10	9.4	8	6	5	4.7	4	3.4
United States 4	2	6	—	18	18	30	—	12	—
Germany ....—	—	—	4	4	40	—	—	10	38

The American superiority is very marked, but it has to be remembered that the Germans, by virtue of their speed advantage, were able to neutralize this on several occasions.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Delayed Orders for American Goods.—I have recently received complaints from buyers of American goods here that not only were they not receiving on time the goods ordered, but were not being courteously treated, in that they were not given reasons for delay or any definite assurances as to the dates of shipment. Manufacturers in the United States being very busy, I have no doubt that the buyers who can meet them in their own clubs, or reach them by telephone or telegraph or by fast mails from near-by points, are by that accessibility able to be so persistent that they receive the goods which in proper turn should be sent abroad. It will not, I hope, be regarded as offensive if I remark that it is not a far-sighted business policy which yields to local importunities and neglects foreign opportunities, present and prospective.

In the middle of October, the representative of a Birmingham firm called to tell me that he had given an order in May last to an Indiana manufacturer, and had not up to date received the goods or even an intimation when they were likely to come. I took it upon myself to write to this manufacturer, urging, as I recollect, that if he could not ship the goods, he should at least write a polite letter to the British buyer, explaining the cause of the delay. The Indiana manufacturer accepted my intermediation, apparently without regarding it as meddling, and wrote me that the Birmingham concern having requested the goods to be sent in one shipment, the order had been delayed "on that account and also on account of labor troubles and many orders ahead." He added: "We are catching up with orders and can make the shipment in a few weeks." When I sent a copy of the letter to the Birmingham firm, they said this gave them the first information they had had on the subject, and they thought that not only should this Indiana manufacturer have written them direct but that he should have stated the cause of the delay at an earlier date.

This morning I received from an important firm in a big city in my consular district a communication which I will give below, as fully as I can without identifying the concerns involved. The manufacturer says:

"I do not know whether it is any use writing to you on the subject, but we are having a bitter experience in buying goods from America just at present. A few years ago, manufacturers in this unfortunate country were severely blamed for not being punctual in deliveries. Those in your country seem now to have gone us one better, or rather one worse. Thus, for example, early in June last we ordered ——— tons of bright drawn-steel rods, made by the well-known ——— Company. We were promised shipment from New York, half the order the middle of August and the other half the middle of September, and to get deliveries we agreed to pay £3 or £4 ($14.59 or $19.46) higher than we could buy in this country."

I should by way of comment state here that I doubt if they could buy goods of the exact quality in this country at any price, but they could buy rods which could be used in a fairly satisfactory manner, provided they went to the trouble of changing "the speed" of their automatic machinery. A friend asserts the change in speed is sufficient, but I have heard a good authority claim that a change in tools was also necessary. United States manufacturers of drawn-steel rods have, in my opinion, never made a sincere effort to get foreign business—possibly owing to the great demand at home—though there has been excellent opportunity, and they have been frequently advised of the fact in consular reports and by American manufacturers of automatic machinery, to whose interest it is to have the stock used on their machines more even in character and size than the general class of English rods.

The letter continues:

"Up to the present time, I have had no deliveries at all, and although we were told that a carload was to be shipped by the steamship ———, on the ——— of November, apparently this has not taken place, as that steamer is in. We have been buying this brand of steel in small quantities from other sources to keep us going, and have paid as much as £5 ($24.33) a ton extra to get deliveries. It is obvious we cannot continue to use this steel (as we have done for several years) much longer, and must return to our own manufacturers in this country.

"Another illustration of the state of things is furnished by the ——— Company, of ——— City, Conn. I placed an order with their London agent for the delivery of a large piece of machinery in August last. They undertook to ship in eight weeks. We are now reaching the end of November, and I have heard nothing about the machine being dispatched, and so on. Forgive my pouring these grievances into your ear in this way, but 'the iron (or more correctly, steel) has entered into my soul.' "—Marshal Halstead, Consul at Birmingham.

Opportunities for Investment in Ecuador.—In reply to a letter from a resident of Minnesota,* Consul-General Thomas Nast wrote from Guayaquil, November 17, 1902:

There are plenty of good opportunities in Ecuador for the investment of money. Corporations are not required to secure special privileges or concessions to transact business, unless it be to establish a bank, in which case it is necessary to conform to the banking laws laid down by Congress, viz., to have a reserve of three-quarters of the amount of the authorized capital in metallic coin, to guarantee the note issue, etc. There is a good opening for a bank here.

The government has refused to grant concessions of land to foreigners in the Napo or Orient, where most of the land is occupied by wild Indians, the chief reason being because the territory is in dispute with Peru; it has also refused rubber concessions in the forests, because of late years the trees have not been properly bled, but cut down.

There is no limit to the land that a corporation may hold.

Rubber.—The planting and growing of rubber trees is considered one of the best investments; but very few have been planted, on account of the large supply of wild rubber and the fear that some artificial matter might be discovered to take its place.

The Congress of Ecuador has decreed that the executive power shall adopt measures to prevent the extraction of rubber from the forests of the western slope of the country during a period of ten years, permitting the exploitation only of the trees cultivated.

The government will pay a premium of 20 cents (9.7 cents gold) for each tree planted after the promulgation of this decree, provided that there are not less than 500 trees at least 1 year old on the plantation. This decree goes into force on April 1, 1903.

Natives engaged in rubber cultivation will be exempted from military service in time of peace.

Export Duties.—There is an export duty on cacao of about $2.50 ($1.21 gold) per quintal (100 pounds); on rubber, about $5 ($2.42 gold) per quintal; on ivory nuts, less than 10 cents (4 cents gold) per quintal.

There is practically no ebony or mahogany in this Republic, but many other beautiful woods are found.

Banking and Currency.—There are two good banks here, and drafts on the United States and Europe are easily negotiated. Ecuador possesses a gold standard, and exchange is always practically the same, viz., about 50 cents United States currency to the dollar (sucre) of this country. The gold coin called "condor" is equal to 10 sucres.

Taxes.—Taxes on real estate are very low, viz., $1 per $1,000, and the assessment is generally about one-half or three-fourths of the value. Property rights are respected.

Health.—Ecuador is reasonably healthy, especially in the country, the prevailing diseases being malarial fevers. One soon gets acclimatized. In Guayaquil and along the coast, the climate during the wet season (from January to May) is very unhealthy. The diseases on the coast are "paludic," "pernicious" fevers, and dysentery.

Minerals.—From all I can learn, there are few minerals to be found here. At present there are two gold-mining companies; and it is reported that the railway company has discovered a coal mine. These three companies are American.

Cacao.—The chief industry of Ecuador is cacao growing, which is extremely profitable. The world's supply of cacao amounts to some 90,000 tons, and of this Ecuador produces 27,000 tons, or about one-third of the total. Land can be obtained at about $1 per acre. It requires about five years to bring a cacao estate into bearing, at a cost of 15 to 20 cents per tree. The trees yield on an average 1 pound each. For a plantation of 100,000 trees, it costs to bring into bearing, say, $17,500. At the end of five years, it is worth $50,000; at seven years, $75,000; etc. The production of 100,000 trees would be 100,000 pounds, worth $11,000 at present prices. The cost of putting this quantity on the market, including labor, etc., would be $4,000, leaving a net profit of $7,000. Estates are easily sold at the above figures, and if a capitalist can wait for results for five years, he is sure of a good income. In the meantime, "catch crops," such as rice or corn, can be grown on the same ground, which is so fertile that for the growing of rice, etc., it is never necessary to plow; a hole is simply made with a machete and the seeds put in, and good returns are obtained.

Industrial Exposition at Rheims.—The Department has received from Consul W. A. Prickitt, of Rheims, notice of the industrial exposition to be held in that city from May 15 to September 6, 1903. This, it is said, is the only exposition to be held in France during the year and is expected to be of great importance from an industrial and agricultural point of view. The hope is expressed that United States manufacturers will participate. The following extracts are taken from the regulations:

All the productions of commerce, industry, agriculture, and the fine arts will be admitted. All explosives and detonating materials judged dangerous and of a character to disturb the public, as well as sparkling wines foreign to the Department of the Marne, are excluded from the exposition. A fixed fee of 20 francs ($3.86) is assessed in exchange for the certificate of admission. The fees for sites in the buildings are, per square meter (10.7 square feet), with right to 3.2 yards height:

	Francs.
Horizontal surface	40=$7.72
Horizontal surface, for machines and farming implements	25= 4.83
Wall surface, not projecting more than 5.9 inches.....	25= 4.83

The fees for outdoor sites are, per square meter:

With privilege of building.....	10=$1.93
With privilege of raising structures.	5= .97

Exhibitors desiring isolated sites or with several sides exposed must mention the fact in their demand for admission. In the section of the beaux arts, paintings, water colors, engravings, and sculpture sites will be free. The charges for unpacking and packing will be at the expense of exhibitors. Water, gas, electricity, or motor power necessary to exhibitors will be furnished on demand and at their expense. French railways have granted a reduction of 50 per cent on the transportation of products destined for the exposition. All communications should be addressed to M. l'Administrateur, Industrial Exposition, Rheims, France.

Bids for Lighting Guayaquil.—Consul-General Thomas Nast transmitted from Guayaquil, November 12, 1902, translation of an advertisement by the municipal council, inviting tenders for lighting the city by gas or electricity. Mr. Nast said:

The tenders must be sent to the secretary, municipal council, of this city, not later than February 12, 1903 under sealed envelope. It is hoped that American capital will try to get the contract. Letters are frequently received asking for investment opportunities in this country.

The inclosure reads:

LICITATION.

The municipal council, in session on the 6th instant, decided to invite tenders for the lighting of this city under the following terms:

1. The city to be lighted by gas or electric light, or by both, within limits provided for in the contract.

2. The lights to be located 3.5 meters (3.8 yards) above the surface and 1 meter (1.09 yards) from the houses' front (portales), and not be farther apart than 35 meters (38.1 yards).

3. Each light to be of 15.4 candle power (international unit); at the intersection of the streets in the central part of the city, the lights to be of 80 candle power, located at a height of 6 meters (6.5 yards).

In all cases, the lights used in the streets shall be arc lights.

4. The council guarantees that it will take at least 1,400 lights during eleven hours daily—also 50 lights of 80 candle power—for which payment will be made monthly.

5. The municipal engineer and the inspectors of lights shall take the usual measures to test the quality of the lights in any part of the city.

6. The gas or electric conductors must be laid underground, and of the most modern system and size.

7. Each house supplied with gas must be provided with the usual key and register located at the entrance or on the sidewalk; in the same manner, switchboards will be located at each section of the electric conductors and opposite each house, so that in case of fire or other cause of interruption of the current at that point; there would be no loss of time and the service in other parts would continue uninterrupted.

8. The company shall have the free use of the streets, lands, and municipal water for all that pertains to the service, and the municipality binds itself to obtain from Congress the free entry of all materials needed for the installation of the service.

Sealed offers will be received until February 12, 1903.

Address: The Secretary, Municipality, Guayaquil, Ecuador.

Sardines in British Columbia.—The attention of a gentleman from the East visiting Puget Sound three years ago was attracted by the large number of small fish that were said to be sardines. He sent for an expert and had a few canned in the regular way. The result was the establishment at Port Townsend of a cannery, the output of which in 1901, its first year, was 60,000 cases. It is estimated that the pack of this year will reach 175,000 cases. It is claimed that these are superior in quality to sardines canned on the Atlantic coast, and equal to the foreign product.

It is said that plans are being considered for the erection of a much larger plant on Puget Sound. The same fish exist in great abundance in waters in the immediate vicinity of this city. The duty imposed upon cottonseed oil has lately been removed by the Canadian government, so that sardines may be packed here as cheaply as on Puget Sound, and they would find a ready market in this Province and as far east as Winnipeg. It seems to me that there is an excellent opportunity for the establishment of such an enterprise in this city or vicinity. The country tributary to Vancouver is rapidly filling up, and there will be an increasing demand for such products.

There is a cannery in this city which proposes to run all the year. After the salmon season is over, it intends to can, dry, or salt other fish, and there has been a suggestion that it extend its operations to the canning of sardines, although I believe no action in that direction has yet been taken.

It seems to me this is an opening well worth the attention of some person with moderate capital.—L. Edwin Dudley, Consul at Vancouver.

* To whom Advance Sheets have been sent.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1514. December 8.—Government Iron Foundry in Japan—French Sardine Industry—German Trade with Cuba—Duty on Cement and Pipes in Costa Rica.

No. 1515. December 9.—Rubber Crop of Brazil: Gutta-percha Industry—Glauchau Weaving School—Weavers' Strike at Meerane, Germany—Dentists in Madagascar—Changes in German Customs Tariff—Physicians in Ecuador—Japanese Enterprises and Foreign Capital.

No. 1516. December 10.—Automatic Outside Brake for Trains—Expenses of the Siberian Railroad—British Inquiry for Builders' Accessories.

No. 1517. December 11.—British Duty on Grain—Financial Measures in Mexico—* Bids for Lighting Guayaquil.

No. 1518. December 12.—Wool Trade in Australia—Notes from New South Wales—Agricultural Banking System in Bahia—Power Works for Vancouver—Development of German Togoland—Design for Monument to the Postal Union at Berne.

No. 1519. December 13.—* Delayed Orders for American Goods—Treaty of Peace in Colombia—Tin in Queensland—* Scarcity of Wheat in Australia—Lighthouses of Zanzibar—Nicaraguan Customs Duties Payable in Gold.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

Shoe Dressings.—It may be that the following formulæ from the Druggists' Circular and Chemical Gazette may be of interest to our readers:

I.

Bone black	2 pounds
Molasses	1½ pounds
Lard oil	¼ pint
Vinegar, enough to make a paste.	

II.

Tragacanth	1 ounce
Water	4 ounces
Dissolve and add	
Neatsfoot oil	2 ounces
Bone black	4 ounces
Prussian blue	1 ounce
Sugar	4 ounces

Glycerin is sometimes used in making such pastes and, we are told, answers a good purpose.

Dressings for Russet Shoes.

The paste dressings used on russet leather consist of mixtures of wax with oil and other vehicles which give a mixture of proper working quality.

A simple formula is:

Yellow wax	9 parts
Oil of turpentine	20 parts
Soap	1 part
Boiling water	20 parts

Dissolve the wax in the turpentine on a water bath and the soap in the water and stir the two liquids together until the mixture becomes sufficiently cold to remain homogeneous.

Another formula in which stearin is used is appended:

Wax	1 part
Stearin	2 parts
Linseed oil	1 part
Oil of turpentine	6 parts
Soap	1 part
Water	10 parts

Proceed as above.

It is said that carnauba wax is used by manufacturers of such dressings instead of beeswax, as it is harder and takes a higher polish.

These dressings are sometimes colored with finely ground yellow ocher or burnt umber. If the leather be badly worn, however, it is best to apply a stain first, and afterward the waxy dressing.

Suitable stains are made by boiling safflower in water, and annatto is also used in the same way, the two being sometimes mixed together. Oxalic acid darkens the color of the safflower. Anilin colors would also doubtless yield good results with less trouble and expense.

By adding finely ground lampblack to the waxy mixture instead of ocher, it would presumably answer as a dressing for black leather.

Dressings for Ladies' Shoes.

Dressings for ladies' shoes must be somewhat varnish-like, so as not to rub off when the leather becomes damp. They of course tend to harden the leather.

A formula for such a dressing is as follows:

Anilin black	5 parts
Camphor	10 parts
Shellac	120 parts
Alcohol	365 parts

Shellac, which is the ingredient giving luster to the dressing, may also be dissolved in an aqueous alkaline solution, according to the appended recipe:

Shellac	2 ounces
Ammonia water	1 ounce
Water	6 ounces
Anilin Black, sufficient to color.	

Boil all the ingredients together, except the anilin, until the shellac is dissolved; then add the anilin and sufficient water to make the liquid up to the measure of 16 ounces.

Hager gives the following formula for producing a similar result in a different way:

Gallic acid	5 grammes
Borax	5 grammes
Logwood extract	2.5 grammes
Anilin black	10 grammes
Ammonia water	10 grammes
Hot water	50 grammes
Aqueous shellac varnish (as below)	2,000 grammes

The aqueous shellac varnish is prepared as follows:

Borax	100 grammes
Water	2,250 grammes
Powdered shellac	300 grammes

Heat the water to the boiling point, dissolve in it the borax, and then add the shellac in small portions, stirring the liquid constantly until solution is effected. When cool, strain.

Liquid Polish for Metal.—The substances in general use for polishing metals are prepared chalk, rottenstone, tripoli and emery. For the finest work jewelers' rouge is employed. This is prepared by calcining precipitated ferric oxide, until it assumes a scarlet color. Substances like emery are most useful for the harder metals; they scratch too much to be used to any extent on gold or silver. All should be run through a fine sieve before being used.

All of these are usually applied moistened with water or mixed with some fatty substance. A so-called "liquid polish" may be made by suspending them in water or some other suitable liquid.

As an example of a liquid cleanser and polish for ordinary use the following is given:

Prepared chalk	2 parts
Water of ammonia	2 parts
Water, sufficient to make	8 parts

The ammonia saponifies the grease usually present.

It must be pointed out that the alkali present makes this preparation somewhat undesirable to handle as it will affect the skin if allowed too free contact.

The density of the liquid might be increased by the addition of soap, the solid would, of course, then remain longer in suspension.

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Volume II contains much on the general subject of electricity, besides new articles of great importance. Among these the subject of alternate current machinery is treated. Wireless Telegraphy and Telephony receive attention. Electrical Measuring Instruments, The Electric Clock, The Telegraphone, Experiments in High Voltage, The Nernst Lamp, and Measuring the Heat of the Stars are all thoroughly illustrated and described.

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